INDIAN PLAGUE COMMISSION.

REPORT

OF THE

INDIAN PLAGUE COMMISSION

WITH

APPENDICES AND SUMMARY.

VOL. V.

Presented to both Houses of Parliament by Command of His Majesty.

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INDIAN PLAGUE COMMISSION.

No. 4360–74.

Extract from the **Proceedings** of the **Government of India** in the **Home Department** (Sanitary / Plague),—under date **Simla**, the 11th November, 1898.

Read:—

(1.) Despatch to Her Majesty's Secretary of State for India, No. 19, dated the 25th August, 1898.

(2.) Telegrams from Her Majesty's Secretary of State for India, dated the 28th September and 2nd November, 1898.

RESOLUTION.

Plague broke out in the City of Bombay during the rainy season of 1896, and has since visited all parts of the Bombay Presidency, the City of Calcutta, the district of Saharanpur in the North-Western Provinces, the districts of Jullundur and Hoshiarpur in the Punjab, several districts of the Madras Presidency, the Hyderabad and Mysore States, the Sirohi State in the Rajputana Agency, and the Gwalior State in the Central India Agency. No efforts have been spared in devising and prosecuting measures to stay the epidemic, and the Government of India think that, although the plague has been widespread, these efforts have been attended in many respects with marked success.

2. The Governor-General in Council is of opinion that the time has now come when it is possible as well as most desirable to obtain reliable scientific opinion as to the manner in which the disease is communicated, the causes of the outbreaks in different parts of India, and the circumstances influencing their growth and decline. The facts connected with the outbreaks of the disease are still very obscure, and no such opportunity has arisen—and it may be hoped that none will arise in the future—as now presents itself for their investigation. A number of interesting facts have already been collected and embodied in the different reports regarding the outbreak of the disease which has prevailed in India for the past two years; but there must be many valuable items of information to be ascertained from officers who have been employed on plague operations that have not been recorded in official reports; and there are also many circumstances connected with the outbreaks at different places which require to be locally examined by persons who can collate the facts and form conclusions which will be accepted by public as well as scientific opinion in respect of them.

The Government of India also regard it as very desirable that an authoritative scientific opinion should be obtained as to the value of prophylactic and therapeutic serum in dealing with plague.

3. The Governor-General in Council has accordingly decided, with the approval of Her Majesty's Secretary of State for India, to appoint a Commission to inquire into the following questions:—

(1) the origin of the different outbreaks of plague;

(2) the manner in which the disease is communicated;

(3) the effects of curative serum; and

(4) the effects of preventive inoculation.

The object with which the Commission is appointed is to conduct an investigation of a scientific character, the results of which will be of the greatest interest and importance not only to the Government of India, but beyond the limits of the Indian Empire.

4. The President of the Commission will be Professor T. R. Fraser, M.D., LL.D., F.R.S., Professor of Materia Medica in the University of Edinburgh. The members of the Commission will be Mr. J. P. Hewett, C.I.E., I.C.S., Secretary to the Government of India in the Home Department; Professor A. E. Wright, M.D., Professor of Pathology in the Army Medical School, Netley; Mr. A. Cumine, I.C.S., a Senior Collector in the Bombay Presidency; and M. A. Ruffer, Esq., M.D., President, Sanitary, Maritime, and Quarantine Council of Egypt. Mr. C. J. Hallifax, I.C.S., will be Secretary to the Commission.

5. The Commission will be formally constituted on the arrival of the members from England. They will first visit the City of Bombay, and will probably then desire to make inquiries in the other parts of India in which plague is or has been prevalent. The Governor-General in Council desires to leave the matter of method and procedure entirely to their discretion. The general conduct of the inquiry and the regulation of the course of business before the Commission will be entrusted to the President in communication with the members. The Commission, through their Secretary, acting under the instructions of the President, will correspond direct with Local Governments and Administrations (including Political Officers in direct relation with the Government of India) and departments of the Government of India and with any local authorities with whom direct communications may be authorised by Local Governments and Administrations as a matter of convenience and in order to save time. It is requested that all communications or requisitions for information emanating from the Commission may be treated as urgent and complied with promptly, and that, in the event of the Commission visiting a Province, they may be afforded every facility for their inquiries.

ORDER.—Ordered, that copy of this Resolution be forwarded to the Local Governments and Administrations for information and guidance, and to the Departments of the Government of India noted in the margin for information.*

Madras.
Bombay.
Bengal.
North-Western Provinces and Oudh.
Punjab.
Burma.
Central Provinces.
Assam.

Coorg.
Hyderabad.
Foreign Department.
Public Works Department.
Finance Department.
Military Department.

* *To Foreign Department,* and communication to Political Officers.

Ordered also, that it be published in the Supplement to the *Gazette of India* for general information.

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[True Extract.]

A. H. L. FRASER,
Offg. Secretary to the Government of India.

CHAPTER I.

QUESTIONS REFERRED TO THE COMMISSION, AND PROCEEDINGS OF THE COMMISSION.

I.—TERMS OF REFERENCE AND SCOPE OF THE COMMISSION.

Questions referred to the Commission by Resolution of the Government of India, No. 4360-74, dated the 11th November 1898.

1. The questions into which we were directed to inquire by the Reference from the Government of India are:—

(1.) The origin of the different outbreaks of plague;
(2.) The manner in which the disease is communicated;
(3.) The effects of curative serum of Yersin and Lustig respectively;
(4.) The effects of preventive inoculation.

We were informed that the object with which the Commission had been constituted was to conduct an investigation of a scientific character.

Necessity for taking evidence regarding facts of plague administration.

2. In the earlier stages of our inquiry we found that it was impracticable to examine witnesses regarding the origin of the different outbreaks of plague and the manner in which the disease is communicated without recording evidence relating to plague administration and its results. The witnesses who came before us were witnesses to facts, and the facts of plague origin and history were found to be inseparably interwoven with the facts of plague administration. At some of the earliest of our sittings we found evidence tendered on matters which were not strictly among those committed to us for investigation by the order of reference, but which we found it impossible to exclude from our consideration if we were to examine all aspects of the questions to which our attention had been directed on our appointment. We, therefore, on our arrival at Calcutta communicated informally to the Government of India the fact that we had recorded a considerable amount of evidence which could not be held to be strictly relevant to the consideration from a scientific point of view of the four questions referred to us, and the difficulties which we felt in excluding such evidence. We were informed by the Government of India that they accepted the necessity for taking evidence regarding the facts of administration. It was left to our discretion to determine how far it was necessary or desirable to comment in our Report on the facts so recorded in evidence. The Government of India expressed the opinion that the purely scientific side of our inquiry should be the main one, and that the object to be aimed at was that our Report should be a document for the information and use not only of the Indian Government but also of other nations generally. It appeared to the Government of India that differences of opinion between various authorities in India might detract from rather than enhance the value of the Report in this respect.

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Report based on record of evidence and other sources of information.

3. These instructions were communicated to us unofficially and no change was considered necessary in the formal orders regarding the scope of our inquiry. The record of our evidence accordingly contains much which is not of a scientific character or strictly relevant to the specific issues definitely communicated to us for consideration. In addition to the evidence which has been recorded and the papers which have been embodied in the appendices to that evidence, we have been favoured by the different Governments, particularly the Government of India and the Government of Bombay, with many other papers to assist us in our conclusions. We have also in the course of our tour in India endeavoured to supplement the evidence placed before us by personal observation. We have taken every opportunity of seeing plague measures in operation in the large towns, such as Bombay, Poona, and Bangalore Civil and Military Station; we have frequently visited plague-infected villages, and examined the village sites, and the villagers in their camps; we have seen the arrangements in many Plague Hospitals; we have seen the inoculation with Mr. Haffkine's prophylactic done; we have, during the course of our railway journeys, closely examined the system for the medical inspection of passengers and the disinfection of their personal effects, and during our residence in Bombay we, on several occasions, observed Major Crimmin's arrangements for the examination of passengers by sea from Bombay, and the disinfection of their clothes. We have had numerous opportunities of personal communication with the officers employed on plague measures, and of observing the attitude of the people. We desire to express our thanks to the Government of India and to the Local Governments as well as to individual officers in their employ

for assistance in the conduct of our inquiry, which has been given to us in the most thorough and complete manner wherever we have been.

Synopsis of subject-matters treated of in this Report.

4. In view of the fact that part only of the evidence recorded by us bears on the scientific study of plague, we have prepared our Report in two parts so that the portion dealing with this question can, if the Government so pleases, be separated from that portion which deals with the evidence regarding the different administrative measures adopted from time to time.

The first part of the Report deals with :—

I. The history of plague in India with special reference to the spread of plague and the origin of the plague epidemics that have occurred in various places;

II. The clinical, bacteriological, and epidemiological data so far as they bear on the mode in which plague is communicated, and the mode in which it is spread from place to place: the clinical facts which have a less direct bearing on the communication and spread of the disease have been treated of in a separate Appendix by the President;

III. The preparation, character, and effect of the particular therapeutic sera which we were directed to study; and

IV. Preventive inoculation by Mr. Haffkine's method.

The remainder of the Report is devoted to a description and consideration of the results of the measures actually adopted to deal with outbreaks of plague, and to the question whether it is possible to make any improvement in them.

In addition to collection of information in general, scientific investigations on special subjects arranged for.

5. We arrived at Bombay on the 26th of November 1898 Our first task on arrival was to settle the programme for our future work. We had, on the one hand, to make arrangements for collecting information with regard to plague in general, both by the examination of witnesses and by personal inspection first in Bombay and afterwards in other parts of India which were being visited or which had in the past been visited by plague. We had, on the other hand, to make arrangements for undertaking certain scientific investigations. These had reference (1) to the determination of the character and effect of Mr. Haffkine's prophylactic fluid; (2) to the determination of the character and effect of Yersin's and Lustig's sera; and (3) to the elucidation (so far as might be possible) of several unsolved problems connected with the propagation of plague, and with regard to the question as to what are the most appropriate measures for combating it.

The steps which we took for carrying out these two entirely distinct tasks may be separately considered.

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II.—PROCEEDINGS OF THE COMMISSION.

Therapeutic effect of Yersin's serum tested, and other bacteriological investigations carried out.

6. We may begin with the description of the arrangements which we made for carrying out the scientific investigations which have just been referred to. In the first place, through the courtesy of the Municipal Commissioner for Bombay, we obtained the use of the small Public Health Laboratory in the Municipal Buildings, which had previously been placed at the disposal of the German Plague Commission. This done we made an application to the Government of India for the services of four selected Medical Officers who had specially distinguished themselves during their course of study at Netley by their clinical and bacteriological knowledge and by their aptitude for scientific research. These officers, whose services were immediately placed at our disposal by the Government of India, were employed upon a variety of scientific tasks.

To Lieut. (now Capt.) H. J. Walton, I.M.S., and to Lieut. Stewart Douglas, I.M.S., was committed in addition to other work the task of testing the therapeutic effect of Yersin's serum upon plague-infected patients. The investigation in question was undertaken first at Bangalore, where an epidemic of plague was at that particular time raging. Afterwards when the epidemic at Bangalore was declining the investigation was continued in Bombay under our direct supervision. To Capt. C. G. Spencer, R.A.M.C., and Lieut. W. G. Liston, I.M.S., were committed a variety of bacteriological investigations.

III. 329-346.

The details of all the investigations which were carried out under our direct personal supervision can be gathered from the evidence of the four Medical Officers who have just been mentioned.

Before bringing to a close this portion of the narrative of our proceedings, we desire gratefully to acknowledge the readiness with which the Government of India met our wishes in the matter of placing the services of these selected officers at our disposal. We desire to express our sense of the great zeal and ability with which each of these officers carried out the scientific task which was entrusted to him. We have also to acknowledge the courtesy of the Government of the Mysore State in placing the services of Dr. Shrinivasa Rau, Chemical Examiner and Bacteriologist to the Government, at the disposal of the President for the purpose of conducting certain bacteriological researches.

Arrival in India, local inquiry in Bombay City and Presidency, Mysore, Madras, Hyderabad (Deccan), Central Provinces, Bengal, North-West Provinces, Punjab, Cutch State, Baroda State, and Daman, and personal supervision by members of Commission of scientific investigations in Bombay.

7. We may now pass on to the narration of the steps which we took for carrying out that larger part of our programme which consisted in the collection of information about plague generally.

We arrived at Bombay, as has been said above, on the 26th of November 1898. We commenced to take evidence there on 29th November.

During this our first visit to Bombay, we determined to confine ourselves to the examination of Mr. Haffkine, Dr. Galeotti (the representative of Professor Lustig), and certain selected witnesses who were very familiar with the course of the plague in the City.

On 5th December we left Bombay for Dharwar and Hubli. We here inquired more particularly into the results which had been obtained by Mr. Haffkine's plague inoculations.

From Hubli we proceeded to Bangalore. The evidence there laid before us dealt in large part with the epidemic of plague, which had at that time somewhat abated in the native City, though it was still very acute in the Civil and Military Station. Further, it dealt with the measures which were being taken to protect the Madras Presidency against infection.

From Bangalore we proceeded to Guntakal to inquire into the circumstances of an epidemic of plague which had occurred in the neighbouring villages. We made an inspection of two of these villages which were being evacuated, and took note of the condition of the evcauated people and of the disinfecting operations which were in progress.

From Guntakal we proceeded to Hyderabad, where we examined witnesses as to the course of plague in the Hyderabad State. From Hyderabad we went to Wardha in the Central Provinces, where evidence was received as to the small outbreak at Hinganghat and Wardha. From Wardha we proceeded to Calcutta, where we arrived on 24th December. We were engaged in taking evidence at Calcutta till 5th January 1899. We proceeded from Calcutta to Northern India. Evidence about the outbreaks at Hardwar and the neighbourhood, the Sirohi State, and Khandraoni in the Gwalior State was recorded by us at Agra, and we completed our inquiry into outbreaks in Northern India at Lahore, where we received evidence about the epidemic in the villages in certain tracts of the Jullundur and Hoshiarpur districts in the Punjab. At this stage one of us proceeded to Bombay to take personal charge of the bacteriological investigations which had already been initiated. We left Lahore on 21st January, and at Karachi on 23rd January opened an inquiry into the outbreaks in Sind.

From Karachi we went to Cutch Mandvi, Ahmedabad, Baroda, Surat, Daman, and Bombay, where we arrived on 9th February. We took evidence in Bombay from 11th February to 22nd February. During this time two of us were continuously engaged in the conduct of bacteriological investigations. We then proceeded to Poona. After completing our inquiry at Poona two of us returned to Bombay. The remainder of us proceeded to Satara, Belgaum, Bijapur, Sholapur, Ahmednagar, and Nasik, and returned on 8th March to Bombay. During this time, and up to our departure from Bombay, two of us were, as before, engaged in bacteriological investigations at Bombay. We again took evidence in Bombay from 13th March to 22nd March.

Number of sittings and conclusion of proceedings in India; arrangements for completion of scientific investigations in progress, and for special inquiry regarding plague in Kumaun and Garhwal.

8. We left Bombay on 25th March 1899. During our inquiry in India we held 70 sittings for taking evidence and examined 260 witnesses, of whom 31 were recalled once and 6 were under examination three times.

Before leaving India we made arrangements for the completion, by Lieutenant Liston, I.M.S., of certain of the bacteriological investigations which were in progress. The results of these further investigations have been incorporated into Lieutenant Liston's evidence.

We also, before leaving India, requested the Government of India to depute Lieutenant (now Captain) H. J. Walton, I.M.S., and Lieutenant Stewart Douglas, I.M.S.,

II. 365-375.

two of the Medical Officers who had been attached to us on special duty, to make a special investigation into the question of the presence of endemic plague in the hill country of Kumaun and Garhwal. The nature of that investigation will be gathered from the instructions which we issued for the guidance of these officers and from the report of their proceedings. These will be found in Appendix XXV. (1) in Vol. II. of the minutes of evidence.

Return to England, record of evidence in London, and consideration of Report.

9. It had at one time been our intention to visit Egypt on our way to England with the object of examining the members of the Egyptian Plague Commission which visited Bombay in 1896–97. As, however, we had obtained in India sufficient evidence upon the points upon which we had proposed to examine Sir John Rogers and Dr. Bitter, we abandoned this intention. One of us (Dr. Ruffer) landed in Egypt, and, on the outbreak of plague at Alexandria a short time afterwards, was detained there on official business until the end of July. The remainder of us proceeded to England. We held two sittings in London for the reception of evidence and then proceeded to the consideration and preparation of our Report. The work in connexion with this latter has been greatly interfered with in consequence of the return of three members of the Commission to their duties abroad.

We desire, in conclusion, to acknowledge in the fullest manner the valuable assistance received by us in the preparation of our Report from our able and energetic Secretary, Mr. Hallifax.

CHAPTER II.

ACCOUNT OF PLAGUE IN INDIA FROM 1896.

I.—DISCUSSION OF THE ORIGIN OF THE OUTBREAK OF PLAGUE AT BOMBAY IN 1896.

Plague in India before and after 1896.

Vol. IV., pp. 155–160.

10. Before we endeavour to answer the first two questions referred to us, viz., the origin of the different outbreaks of plague in India in and after 1896, and the manner in which the disease is communicated, it is necessary to give some account of the spread of plague more particularly subsequent to the period covered by the historical account given by Mr. Nathan in Vol. I., pp. 71 to 94 of the collection of official reports entitled "The Plague in India, 1896–97." We have here carried the history of plague in India down to September 1899, the date of the last reports which reached us before two of us had to return to duty in India and Egypt respectively, and were no longer able to take an active part in the Proceedings of the Commission. The prevalence of plague in each half-yearly period from 1st October 1896, to 30th September 1899, is exhibited in the six maps of India, which are printed as an Appendix to our Proceedings.

Introduction of plague into Bombay City: infection from the Himalayas improbable.

901; 18,276.

6181.

977, 948, 1027, 1545 *seq.*

8834–6.

6184–6.

26,691–700.

11. The manner in which plague was introduced into Bombay City is very obscure and defies elucidation. Even the exact date of the introduction cannot be ascertained. Some witnesses go so far as to say there was no recent importation, and that plague was already present in Bombay before 1896. This theory, however, needs no refutation, inasmuch as, if plague had been occurring in Bombay before 1896, it would certainly have come under the notice of the medical profession in the City. There is no reason for thinking that, except when the districts in the immediate neighbourhood of Kumaun were infected in 1853–4, plague had been present in the plains of India since the outbreak of 1836, until it appeared in Bombay during the rainy season of 1896. Lieut.-Col. Weir, I.M.S., and Mr. Vincent, late Commissioner of Police in Bombay, suggest that the disease was imported from Kumaun, and the grounds that are adduced in support of this theory are that between May and August 1896 numerous pilgrims from Kumaun came down to Nasik and Bombay, and that sudden deaths are reported to have occurred among them. But there is nothing to show that these pilgrims had plague among them, or that they came from any place in the Hills where there was plague. On the contrary, it appears certain that there was no considerable outbreak of plague in the Hills for some time before the Bombay outbreak occurred. Even when there has been plague in the Hills, the experience of the past teaches us that it has shown little tendency to spread even to the neighbouring districts of the plains. In case the disease was carried to Bombay from the Hills, it would naturally make its appearance first in the neighbourhood of the Hills, and it is very improbable that infective material could have been carried so far from the Hills as Bombay without causing outbreaks in places through which it was carried on its way, for it takes 10 days to reach Bombay from Kumaun, even if the journey is not broken, and pilgrims are in the habit of travelling slowly and of stopping at many places *en route.* Moreover, the plague in Bombay City, when first brought under the notice of the authorities, was

not found in the quarter of the City in which its appearance might have been expected if it had been introduced into their lodgings by Kumaun pilgrims.

1023.

Theory of the introduction of plague into Bombay City from Hong Kong.

12. When first detected, plague was found to have obtained a hold upon the Mandvi quarter, and it remained confined to that quarter for some time. This quarter is that of the docks and of the warehouses in which imported merchandise, and grain for export are stored. The fact that plague first broke out here manifestly favours the theory that the infection was imported by sea. No definite facts, however, have come to light to show that it was so imported. On the one hand, there is no record of the occurrence of plague among men or rats on board ships arriving at Bombay before the outbreak of plague in the City; on the other hand, there are no clearly established facts pointing to importation in clothes or merchandise. The only attempt to propound any definite theory regarding the first outbreak of plague in Bombay was that made by Mr. Ismail Jan Mahomad and the Honourable Mr. Bhalchandra Krishna. About the 15th of August 1896, the first-named witness saw in one house two fatal cases of disease characterised by fever and pneumonic symptoms which he afterwards concluded to be cases of plague. The patients in question had been at Nasik for some days before they took ill, but Mr. Ismail Jan Mahomad thinks that the disease was in both cases contracted at Bombay, because "there was at the time no plague at Nasik," while in Bombay "there was already a scare of the men of the firm" to which the patients belonged, on account of sickness that had broken out among them. From subsequent inquiries, it appeared that, in the neighbourhood in which the cases were observed by Mr. Ismail Jan Mahomad, there were warehouses of Chinese goods—tea, sugar, and silks—and in Argyle Street, where plague was first detected and where it was very severe, there were three warehouses containing Chinese crackers imported from Hong Kong. In one of the sugar warehouses and in a granary at the back of that warehouse, dead rats had been found before the middle of August, and Mr. Ismail Jan Mahomad's two patients, to whom have just been referred, lived in a house adjoining the sugar warehouse where rats died. Plague cases also occurred in the house above the granary where rats died. Crackers, it is said, are imported in the early part of July and in the beginning of August for use at festivals that take place about that time, and it is suggested that the infection was imported in them from Hong Kong and was communicated to rats and then by rats to men. The above shows that the evidence which connects the Chinese crackers in question with the origin of plague in Bombay City is of the slenderest. What appears to be fairly well established—and beyond this everything would appear to be doubtful—is that plague cases occurred first in the Mandvi quarter, and that they were, as appears to be shown by the evidence of Dr. Underwood and Mr. Engineer, occurring there as early as the month of July 1896. The first cases officially recognised were, however, the cases reported by Mr. Viegas on the 23rd of September 1896.

911.
776, 1191.
17,760 *seq.*
19,016 *seq.*
19,133, 18,295.
579–80.

Importation of plague into Bombay City by sea probable.

13. The plague must, in our opinion, have reached Bombay by sea, but, as we have just seen, we found it impossible to procure any evidence to show from what place it was brought. Hong Kong was, indeed, infected for some time before plague appeared in Bombay, and the possibility of the importation of infection directly from Hong Kong is established by the fact that a case of plague was actually landed at Bombay in the course of the third epidemic, in March 1899, from the steamship *Bormida*, which came from Hong Kong. There is, however, nothing definite to connect the existence of plague in Hong Kong with the outbreak in Bombay, and it is at least possible that plague may have come to Bombay from some endemic focus in the Persian Gulf or Arabia.

25,506.
Vide infra. Bormida.

Outline of the treatment of the history of plague in this Report.

14. In attempting to give a historical account of the spread of plague in each season it will be convenient to refer in detail, first to Bombay City, then to the Presidency of Bombay and Sind, to which plague has been, with a few exceptions, confined hitherto, and lastly to the comparatively few places which have been infected in other parts of India. Before referring to the statistics of the outbreaks in particular places, we will give a brief general outline of the course of plague during each of the three periods of its increase and decline between September 1896 and June 1899.

II.—SKETCH OF THE COURSE, TO THE END OF JUNE 1899, OF THE PRESENT EPIDEMIC OF PLAGUE IN INDIA.

The geographical limits and description of the Bombay Presidency and Sind.

15. The Presidency of Bombay is an irregular strip of land stretching along the eastern coast of the Arabian Sea as far as the valley of the Indus. The continuous coast line is broken on the north only by the Gulf of Cambay and the Gulf of Cutch, between which Kathiawar, a tract of country containing 187 small Native States, projects. Along the long coast line there are numerous ports. In other directions the

Bombay Presidency is bounded by the Mysore State (on the south), the Madras Presidency (on the south-east), the Hyderabad State, the Hyderabad Assigned Districts, and the Central Provinces (on the east), the Native States of Central India, and the Native States of Rajputana (on the north). To the north of the River Narbada lie almost the whole of the Province of Gujarat (containing the British districts of Ahmedabad, Kaira, the Panch Mahals, Broach, and Surat), the Baroda State, a number of Native States, and the Province of Sind. Sind is bounded by the sea and the Rann of Cutch (on the south), the States of Rajputana (on the east), the Punjab (on the north-east), and Baluchistan (on the north and west). To the south of the Narbada there are three tracts, the Konkan (including Bombay City and Island, and the Thana, Kolaba, and Ratnagiri, districts), the Deccan (including the Nasik, Ahmednagar, Ponoa, Sholapur, and Satara, districts), and the Southern Mahratta tract (including the Belgaum, Dharwar, and Bijapur, districts, and the Native States included in the Kolhapur country). The two districts of Khandesh and Kanara do not fall strictly within any of these three divisions, but adjoin the Deccan and the Konkan respectively.

Extent of infection in the Presidency since 1896.

16. Bombay City has remained continuously infected since the discovery of plague there in September 1896. From time to time plague has occurred in every one of the districts in the Bombay Presidency proper, and in many of the Native States adjoining the British districts. In some districts the infection has been very severe, in others very mild. In Sind there have been three epidmics at Karachi, and several other places in Sind have been attacked.

Course of the plague up to June 30th, 1897.

17. Between the outbreak of plague in Bombay in the autumn of 1896 and 30th June 1897, the town of Karachi was attacked and the outbreak in Sind occurred. In the Bombay Presidency proper, the main seat of the infection was during this period the Konkan coast, from Surat to Ratnagiri, which includes Bombay, Surat, Thana, Kolaba, part of the Baroda State, and the small Portuguese possession of Daman. Another tract affected at this time was the west and centre of the Deccan districts, including the districts of Nasik, Poona, Satara, and Ahmednagar. The Eastern Deccan districts and the British districts in the Southern Mahratta country escaped any serious infection at this time, but the Kolhapur country was infected. There were scattered indigenous* cases of plague in the Gujarat districts north of the Surat district, but the only outbreak of any consequence was at Palanpur, the capital of the Palanpur State. There was a virulent epidemic at Cutch Mandvi, the capital of the Cutch State.

Up to 30th June 1897, the only places outside the boundaries of the territory controlled by the Bombay Government from which indigenous plague had been reported were the small village of Khandraoni, in the Gwalior State, and Hardwar, in the North-Western Provinces.

Course of the plague from July 1st, 1897, to June 30th, 1898.

18. In the next period, from 1st July 1897, to 30th June 1898, the Konkan coast was not generally so badly infected as in the previous period. There were bad epidemics at Karachi, Surat, Cutch Mandvi, Baroda, and Palanpur, on the north. The principal centre of infection, outside Bombay City, moved to the east and south. The districts of Poona, Satara, Sholapur, and Ahmednagar suffered, and at each of the chief towns in these districts there was an epidemic. The Khandesh district was slightly infected. The infection spread in the Kolhapur State and to the adjoining district of Belgaum.

During this period there were four new seats of infection outside the Presidency of Bombay and Sind. The villages of the Hyderabad State adjoining Sholapur and other Bombay districts became infected in December 1897. Calcutta was infected in April 1898. The villages in parts of the Julluudur and Hoshiarpur districts in the Punjab were infected in October 1897. A few villages in the Sirohi State, in Rajputana, were infected in November 1897. The infection spread from Hardwar, in the North-Western Provinces, to other places in its immediate neighbourhood.

Course of the plague from July 1st, 1898, to June 30th, 1899.

19. In the third period from 1st July 1898 to 30th June 1899, the chief seats of plague were the Dharwar, Belgaum, and Satara, districts and the Kolhapur country. The rural areas in this part of the country suffered severely, as well as the towns of Belgaum, Dharwar, and Hubli. The outbreaks in the tracts in question reached their highest point in October and November, and then declined to small proportions in May, with a slight increase again in June. In the Sholapur, Poona, and Bijapur districts there were outbreaks which culminated in October, November, and January respectively. In Kathiawar an outbreak occurred which reached its climax in September. In Thana there was an outbreak in which the number of cases reached

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* The use of the term "indigenous" in this sense is not strictly accurate, but it is adopted in this Report as it has been generally used in India.

a high point in August, and then, after declining till November, increased again till March, when another decline commenced. In Nasik there was a considerable amount of plague in October, and in this district as well as in Surat and Broach, where there was plague, the disease, after declining at the end of 1898, increased in the first months of 1899, and decreased after February. In Kaira, the Panch Mahals, and Khandesh also there were outbreaks which were at their worst in January and February 1899.

In Bombay City the number of cases was highest in March 1899, and then began to decline. Cutch Mandvi and Baroda were again attacked in the beginning of 1899, and another severe outbreak commenced in February in Poona City, while Karachi City was severely affected from February to May.

To the south of the Bombay Presidency a very malignant outbreak took place in the Mysore State. Some districts of the Madras Presidency also became infected. An outbreak occurred in the Central Provinces, but it was confined within narrow limits. Calcutta, certain parts of the Hyderabad State, and some villages in the Punjab also suffered in this period.

III.—DETAILED ACCOUNT OF THE COURSE, TO THE END OF JUNE 1899, OF THE PRESENT EPIDEMIC IN INDIA.

Remarks as to the statistics regarding attacks and deaths from plague.

20. In the more detailed account of the spread of plague which follows, we have endeavoured to give a short outline of the course of the outbreaks in the larger towns.

As the figures which we quote may not in all cases be found to coincide exactly with those given in some of the official reports, we would explain that we have found difficulty in reconciling exactly some of the different returns of plague cases and plague mortality which we have received. The differences have, however, in no case been of any material importance, and have often been due to the returns not having embraced exactly the same periods.

For the Bombay Presidency and the States connected with it, the figures we have adopted have generally been taken from the official weekly returns of the Bombay Government, which have been supplied to us. These give a more uniform basis of comparison between different towns and districts than the figures separately supplied by witnesses, all of which are not prepared on one system. Moreover, the official weekly returns of the Bombay Government enable us, in carrying on the history of the disease in Bombay beyond the date on which we ceased to take evidence, to use figures that can be compared with those relating to the period up to the date on which we ceased to take evidence.

Vol. IV., pp. 155–160.

In preparing the appended maps, consideration has been given only to fatal indigenous cases, and in the case of towns—except Bombay, Poona, and Karachi—the official weekly returns give us figures for indigenous cases only. Where for this or any other reason, such as the necessity of quoting figures for a period not coinciding with any given in the returns, we have used figures not taken from the returns, the source whence our figures are derived is quoted in the margin.

We have made especial use of the following reports regarding the outbreak in Bombay City, viz.:—

(1.) Report on the outbreak of Bubonic Plague in Bombay, 1896–97, by P. C. H. Snow, Esq., I.C.S., Municipal Commissioner for the City of Bombay.

(2.) Report on the Bubonic Plague in Bombay, by Brigadier-General W. F. Gatacre, C.B., D.S.O., Chairman, Plague Committee, Bombay, 1896–7.

(3.) Report of the Bombay Plague Committee on the Plague in Bombay, for the period extending from the 1st of July 1897 to the 30th April 1898, under the Chairmanship of Sir James MacNabb Campbell, I.C.S., K.C.I.E.

For places outside the Bombay Presidency we have adopted figures supplied to us in periodical reports with which we have been favoured by the local authorities, and have cited the authorities from which we have obtained other figures quoted in this history.

We have, as a rule, given the population of the towns as it was ascertained in the census of 1891. The population is, in most instances, believed to be considerably higher now, but the increase is more or less a matter of guess work. In calculating the incidence of plague attacks on the census population, there is a considerable margin of error, since it has generally happened in large towns that part of the population fled during the progress of an epidemic. Generally speaking, however, a calculation of the rate of attack on any assumed population would also be erroneous. We therefore think it best to calculate the incidence on the census population, and to point out that the incidence was nearly always higher, and very often much higher, than this calculation would show.

III.—(*a.*) *History of the Plague, to the end of June* 1899, *in Bombay City.*

First outbreak in Bombay City. 1018, 1175. 892.

21. Plague was officially recognised in Bombay City on 23rd September 1896. Suspicious cases had occurred before that date, and it is clear that a number of them were true cases of plague The mortality in the City, which had been 2,299 in July 1896, was 2,669 in August, and 2,616 in September. The exact date, however, of the first occurrence of a case of plague has not been, and cannot now be, ascertained.

Bombay City. Measures adopted at first under the management of the Municipal authorities. Mr. Snow's Report Para. 7 and pp. 72-3, 908-916.

22. The responsibility of dealing with the plague was, in the first instance, left with the Municipal authorities. To assist them in suppressing the outbreak special powers for dealing with it were, on 6th October 1896, conferred on the Municipal Commissioner, under Section 434 of the City of Bombay Municipal Act of 1888. On that date the Commissioner issued a notification, firstly, requiring any person having the control or charge of a building to open it on the demand of any authorised Municipal officer, and to permit it to be cleansed and disinfected, and any articles in it to be removed for disinfection or destruction; secondly, rendering any person, certified by the Executive Health Officer of the Municipality or by any duly qualified medical practitioner to be suffering from bubonic fever, liable to be removed to a hospital for the treatment of that disease; and, thirdly, providing for the isolation of any house in which a case might occur.

Bombay City. Effect of measures first adopted, and their modification.

Mr. Snow's Report. Para. 9.

23. The provisions of this notification, and particularly the one relating to the removal of sick persons to hospital, caused great alarm and excitement. The great majority of cases were concealed, and the most extraordinary rumours were circulated as to the intentions of Government in wishing the people to go to hospital. In consequence it became necessary (on 30th October) for the Municipal Commissioner to issue two proclamations—one addressed to the public and the other to the mill-hands—explaining and modifying the orders issued about segregation on the 6th. These proclamations contained a promise that no sufferer from plague should be removed to hospital from premises in which proper segregation and treatment could be carried out, and that where removal to hospital was necessary no action should be taken except upon the certificate of a qualified medical practitioner employed under the Municipal Health Department.

The practice actually followed at this time was that, when a case of plague had been detected, the patient was removed to the room in his house which had the best light and ventilation, and endeavours were made to prevent all but the necessary attendants from frequenting the portion of the house occupied by him. Where suitable arrangements could not be made in the house, or where the patient was a pauper or friendless, he was taken to the Municipal Hospital.

There was not at this time any general evacuation of infected houses or segregation of the healthy residents from them. But in particular instances, where the disease appeared with concentrated virulence in a house, the whole of the residents were removed. This measure did not meet with the same objection as the removal of the sick to hospital, but it was not carried out on any very large scale, and the camps which the Municipality provided for healthy persons were not freely used.

Bombay City. Disinfection of infected localities in first outbreak. Mr. Snow's Report. Para. 13.

24. At the time when the outbreak occurred the Municipal Commissioner had not at his disposal either the trained staff or the supply of articles necessary for thorough disinfection on a large scale. Great efforts were, however, made to disinfect infected localities. The steps which it was thought advisable to adopt were the following:—

(1.) A thorough cleansing and disinfection of every room in which a case was reported to have occurred, and the overhauling and disinfection of all traps and household connexions;

(2.) The sprinkling of dry chloride of lime or carbolic acid powder over the floors and passages both of the affected and of the neighbouring houses;

(3.) The thorough flushing of the affected building, the opening of the roof, and the removal of all obstructions to light and air;

(4.) The burning of all rags, old clothes, and rubbish, found in the affected building, and the disinfection of all valuable articles liable to infection;

(5.) The limewashing of the whole of each affected house before re-occupation;

(6.) The closing for 20 days of every warehouse for the storage of grain in which plague was shown to have taken place, the exposure of the grain and other merchandise to the sun, and the flushing and disinfection of the warehouse;

(7.) The closing, limewashing, and complete fumigation for three days, of every shop in which a case occurred, and the exposure to the sun of all goods in it for at least 24 hours.

These operations were energetically undertaken in infected localities and were accompanied by other measures taken in areas not yet infected. Wherever the approach of plague was feared, disinfectants were distributed to the people with instructions how to use them, instructions which, apparently, they seldom followed. The sewers in certain parts of the town were specially flushed and disinfected with perchloride of mercury and phenyle in November, and limewashing was carried out on a large scale throughout the greater part of the City and suburbs in December. Powers were taken in February 1897 under the Epidemic Diseases Act to prohibit the use of insanitary houses, or to demolish them, compensation being given to the owners. Many temporary erections were burnt, many insanitary houses were condemned and demolished, and many were altered and improved.

25. The outbreak of plague in Bombay City was followed by an exodus of the population, which, though ultimately great, was not of large proportions in the early days of the epidemic. The population of the City was returned in the census of 1891 at 821,764, but it was estimated to have increased to 846,000 in October 1896. In October 1896 about 20,000 left the town. It is estimated that during the last two months of the year the population was reduced by 171,500, and in January 1897, by 187,400 more.

By the end of November there had been 887 attacks and 643 deaths from plague. In December the number of reported cases of plague rose to 1,655 with 1,160 deaths, in January 1897 to 2,374 with 1,835 deaths, and in the first 26 days of February to 2,958 attacks with 2,873 deaths. In the middle of February the number of attacks and deaths began to abate, and from the end of that month, by which time the population had fallen to 450,000 approximately, native opinion began to be reassured and the people to return to the City. Outsiders also began to flow into Bombay till the end of June, numbers of them unfortunately being indigent and under-fed people who were feeling the effects of the famine year.

Plague attacks and deaths, and movement of population, Bombay City from September 1896 to the end of February 1897.
Mr. Snow's Report. Para. 25.

26. In the early part of March 1897 the Government of Bombay determined to relieve the Municipal authorities of the control of operations against the plague in the City of Bombay, and to appoint a Committee, consisting of Brigadier-General Gatacre, C.B., D.S.O., Chairman; P. C. H. Snow, Esq., Municipal Commissioner; Surgeon-Major Dimmock; and C. C. James, Esq., Municipal Engineer; with Surgeon-Lieut.-Colonel Weir, the Health Officer of the Municipality, as Chief Medical Officer of the Committee, to take charge of plague operations with effect from 1st April. The appointment of this Committee was resolved on by the Bombay Government owing to its view that it was evident that the continued existence of plague in the City, in spite of the thorough cleansing operations undertaken by the executive of the Municipality, showed that it could not be stamped out by such measures.

Bombay City. Plague Committee under General Gatacre assumed control from 1st April 1897.

27. The total mortality in the City from 23rd September 1896, the date on which plague was recognised, up to 31st March 1897, when the Municipal authorities ceased to be responsible for the working of measures against the plague, was 33,161. The normal mortality for this period might, had the town been full, be taken at 13,318. The difference between these two figures is 19,843. The recorded plague mortality was, however, only 9,142. Thus it would appear that considerably more than half the cases remained undiscovered during this period.

Plague mortality in Bombay City from commencement of outbreak until the appointment of Plague Committee.
25,719-20-21.

28. The measures to be taken by the Committee over which General Gatacre was appointed to preside were intended to comprise an organization for—

(1) the discovery of all cases of plague;
(2) the treatment of all cases in hospitals, which were to be provided for persons of different castes at convenient places; and
(3) the gradual segregation of those living in the same room with, or in close attendance on, a person found to have the plague.

Bombay City. Measures adopted by General Gatacre's Committee.
General Gatacre's Report, p. 5.

29. The Committee divided the town into ten districts, each in charge of a responsible Medical Officer. The duties of these Medical Officers were—

(i) to superintend and exercise sanitary supervision over the whole district in their respective charges, reporting daily to the Plague Committee and the Health Officer;
(ii) to supervise the working of the district hospitals and to attend the same;
(iii) to supervise the work of the search parties in conjunction with the Justices of the Peace;

Bombay City. Duties of officers put in charge of divisions by General Gatacre's Committee.
General Gatacre's Report, pp 7 and 8.

(iv) to control the disinfection of the infected areas and buildings;
(v) to inspect all segregation camps in the districts;
(vi) to call the attention at once of the officer appointed by Government for the condemnation of insanitary buildings to any such premises in their districts;
(vii) to report on the registration of burials and cremations in their districts and to supervise the sanitary condition of cemeteries;
(viii) to send daily reports to the Plague Committee and the Health Officer of what had happened in their districts in the previous 24 hours together with suggestions.

Each district was divided into sub-divisions and each sub-division into sections.

Bombay City. Search parties in first outbreak. General Gatacre's Report, pp. 177-183.

General Gatacre's Report, p. 18.

30. The attempt was made to discover the cases of plague through the Justices of the Peace, who volunteered for this duty, assisted by search parties of soldiers. The proclamation issued to the public on the subject announced that it was necessary to remove all persons suffering from plague from their houses for a short time, and to treat them in hospitals public and private. The presence of the Justices of the Peace was intended to reassure the people that nothing contrary to their religion or needlessly offensive to their prejudices was intended. The number of soldiers employed was 26 British non-commissioned officers and men with three officers, and 566 native non-commissioned officers and men with four British and 11 native officers.

Work was commenced at 7 A.M. each day, and endeavour was made by the Justice of each sub-division to visit as many houses as possible within it each day. Whenever a Justice found a sick person he made a note of the place and left a sepoy on guard. On the conclusion of his work the Justice gave his report to the sub-divisional Medical Officer, who then proceeded to arrange for the despatch of ambulances. Every sick person had to be seen by the sub-divisional Medical Officer or one of his assistants before being removed to hospital, or, if a female, by a lady doctor whenever this was possible.

Bombay City. Plague hospitals in first outbreak. General Gatacre's Report. Chapter II.

31. An important item of the Plague Committee's work was the establishment of temporary hospitals for the reception of persons suffering from plague. The Committee aimed at procuring such situations for the hospitals that the removal of patients to them from any part of a district should not involve movement over too great a distance, and so add the fatigue of transport to the dangers of the disease. In some of the larger districts it was found necessary to erect a hospital in each sub-division. Private hospitals were only sanctioned when they were open to all the members of any particular caste or sect, and all applications for hospitals for private individuals or groups of individuals were refused. Conditions insisted on before a private hospital could be established were that all arrangements must be carried out by a hospital board, and that the medical attendants and staff must be under the supervision and control of the Medical Officer of the district in which the hospital was located. There were fifteen hospitals maintained by Government, and twenty-eight private hospitals.

General Gatacre's Report, pp. 12-14.

Bombay City. Disinfection in first outbreak. General Gatacre's Report, pp. 183-5.

32. Immediately after the removal of a patient to hospital disinfection commenced. It appears that, as a general rule, only the quarters in which the infected person had lived were disinfected, although sometimes the whole house was done. All rags, bedding and clothes belonging to the patient were removed and burnt, and the infected place was treated with a solution of perchloride of mercury. The solution was, in April 1897, fixed at a strength not weaker than 1 in 1,000, and the additional precaution was taken of digging up the floor, if of earth, to a depth of four inches. The poor received compensation for articles burnt and valuable property, and the contents of infected shops and warehouses were exposed to the sun and air in the road under a guard for three days. As soon as the disinfected place dried up, the walls, floor, and ceiling, were limewashed with quicklime, laid on hot. In addition to the infected room the privies, traps, and water spouts, were disinfected, and the roofs opened so as to admit light and air thoroughly. The re-occupation of a disinfected place was not permitted except with the previous sanction of the District Medical Officer.

Besides the actual disinfection and limewashing of the inside of houses affected with plague, steam flushing engines were used to thoroughly wash down the outside of the premises, and the gullies, drains, and traps, were flushed with disinfectants. When four or more cases had occurred in one house the place was vacated, and was not re-occupied until the District Medical Officer had been satisfied that it was free from infection. When the house was in such an unsatisfactory sanitary condition as to be unfit for human habitation it was vacated, condemned by a Sanitary Board, and marked with the letters U. H. H. The Municipality provided huts for people thus turned out of their houses.

Plague mortality in Bombay City, from appointment of Plague Committee till General Gatacre's retirement from it on 30th June 1897.
25,719–21.
25,722.
Sir James Campbell's Report, p. 1.

33. General Gatacre's work on the Plague Committee ceased on 30th June 1897. The total mortality during the three months while he was at the head of the Committee was 8,379, or only 1,341 above what might have been expected as the normal mortality had the full population of the City been present in it. The number of reported plague deaths was 1,743. The population present in the City during June 1897 was estimated at 750,000. The mortality in this month was 2,326, or about 600 more than the normal mortality of a population of this size at the rate of 28 per thousand per annum. The plague had declined to a very small amount, but there were a number of destitute immigrants in the City, and labour was scarce and prices high. Many of the houses declared unfit for habitation had been unavoidably re-occupied. There were thus distinct elements of danger favouring a revival of the plague.

Bombay City. Sir James Campbell succeeds General Gatacre as Chairman of Plague Committee on 1st July 1897.
25,721.
Sir James Campbell's Report, pp. 3–10.

34. From 1st July 1897 Sir James Campbell became Chairman of the Plague Committee. There was at that time considerable difficulty in obtaining the medical staff required. Officers of the medical services in India were required for famine relief, and subsequently for the operations on the North-West frontier, and the medical men sent to India from England on temporary engagements did not arrive till September. During July there were only 42 registered plague deaths. In August an increase occurred in the number of plague deaths registered, and a considerable increase in the total mortality due mainly to a serious outbreak of cholera. People began to arrive in the middle of August by sea from Cutch Mandvi, and, to guard against the spread of plague in the City by means of imported cases, camps were opened in which arrivals from Cutch and Karachi were detained for ten days. People arriving from the Konkan by boat were also detained. The Wari Bandar Hospital was converted into an observation camp, and enlarged so as to accommodate about 1,500 inmates. At the beginning of September the death-rate was fifty per cent. above the normal, and it rose during the month. The cholera outbreak of July and August was over, but there was a severe outbreak of relapsing fever. The number of plague cases reported in the four weeks ending on the 1st of October was 209, and of deaths from plague 159. Large numbers arrived in the City from the infected districts of Satara and Poona by boats from ports in the Ratnagiri district. A fresh observation camp, to accommodate 2,500 inmates, was opened at Modikhana. During the first half of the month of October the total death-rate and the recorded plague deaths both decreased. Plague cases increased in the second half of October, and from the 2nd to the 29th of the month 262 cases and 165 deaths were reported. The Plague Committee, owing to the cases and deaths outside the City of Bombay being nearly twice as numerous in October as in September, proposed to subject to quarantine persons arriving in Bombay from infected districts by land, but, owing to the objections of the Chamber of Commerce, quarantine was not introduced as a general measure during October. Special steps were, however, taken to prevent persons of the lower classes from bringing infection from the badly-infected cities of Sholapur and Surat. Third class passengers from Sholapur were removed from the train at Sion, and sent to the segregation camp, and orders were issued to stop the booking of third class railway passengers from Surat. These measures were followed by the enforcement of quarantine from the 19th November.

Second outbreak in Bombay City. December 1897.

Sir James Campbell's Report, pp. 12–14.

35. There was no very great increase in the number of reported plague cases in November, 430 having been reported in the five weeks from the 30th October to the 3rd December. The first part of December passed without a serious rise. In the week ending 18th December, however, plague began to increase generally, and especially in the east and west of the town. The cases reported from the 4th December to the end of the month increased to 769, and the deaths to 605. Two measures came under consideration in his month, viz. :—

(i.) The segregation of "contacts," meaning thereby the patient's family and all who have been intimately associated with the patient;

(ii.) The vacation of infected or unwholesome houses, combined with the removal of the inmates to health camps.

Bombay City. Segregation of contacts in second outbreak.
Sir James Campbell's Report, p. 12.

Hitherto the segregation of contacts had been limited to encouraging or requiring one or at most two members of the family to accompany and attend the patient in hospital. The inmates of emptied houses were generally allowed to find fresh lodging where they liked. The rules now made regarding contacts provided that in large chawls (tenement-houses which often contain many hundreds of people), unless several attacks had taken place, it was not usually necessary to segregate the inmates of more than two or three rooms, and contacts in large private houses were permitted to be segregated either in another part of the house or in an outbuilding. Isolation was allowed in private segregation camps which had been certified fit for the purpose. The inmates of public segregation camps were supplied with rations, and the bread-winner (male or female) was allowed to go to work provided the night was spent in the camp. All the clothes of contacts were disinfected on their admission into the camps.

Bombay City. Health camps in second outbreak. Sir James Campbell's Report, p. 13.

The second measure was the emptying of infected and unwholesome houses, and the placing of the inmates in health camps. The Committee considered the question of constructing large health camps in the Harbour Islands or Salsette. The Harbour Islands were found unsuitable from want of water, but convenient sites were found to be available in Salsette. These sites, however, being distant from Bombay, were suitable for the well-to-do classes only. The working people could not face either the going so far from their houses, or the time required for the daily journey. Arrangements were accordingly made to construct camps on the Dadar Flats, and at other places on the Island of Bombay, to accommodate 40,000 persons.

Bombay City. January and February, 1898. Measures adopted in the beginning of 1898, and the movements of population. Sir James Campbell's Report, pp. 16-21.

36. In January 1898 the epidemic became much more serious. In the first 28 days of the month the plague attacks rose to 2,532, and the deaths to 2,515. Bombay was practically isolated. No person, unless he was a resident in an uninfected quarter who had been for seven days previously under the supervision of the local Medical Plague Officer, was given a pass to leave the town without spending in the Modikhana camp the seven days previous to his departure. Ten days' detention at Kalyan and Bandra was imposed on persons leaving by railway. Native craft were prohibited from taking passengers from Bombay to any port between Karachi on the north and Bhatkal on the south. The detention of persons arriving in Bombay was stopped on 25th January. The Marwari and Gujarati traders left in large numbers during the month, and the excess of departures over arrivals was, in January, about 57,000, and in February, about 36,000. The total excess of departures over arrivals between July 1897 and April 1898 inclusive,—the people beginning to return in the latter month—was about 155,000.

During January a beginning was made in the formation of military search parties with a force of 50 men, under Major Ross, who were employed only in two quarters of the town occupied by Parsees and lower class Hindus. The staff of soldiers was somewhat increased in February. In the four weeks ending February 25th there were 4,591 reported cases and 4,464 deaths.

Bombay City. Corpse inspection. Sir James Campbell's Report, pp. 23-27.

37. Early in March, the Committee had discussed the question of corpse inspection. They determined that it was not in agreement with the customs and feelings of any class in Bombay, that any attempt to enforce it was likely to give rise to active ill-feeling, and that the possible advantages from the practice were outweighed by the certainty of discontent. The rumour was circulated that corpse inspection was to be introduced, and on 9th March 1898 a riot occurred in connection with the taking of the daughter of a Muhammadan weaver to hospital. The riot was followed by a strike among cartmen and dockyard workers on 11th March. On 15th March the Governor announced that medical search parties would be replaced by the formation of a large number of volunteer committees. This change took effect from the 17th March, but was not in full working order till the middle of April. The number of recorded plague cases during the period from the 26th February to the 1st April was 5,449, and deaths 5,512. The climax was reached on 18th March, when the epidemic began to decline. When the turn had been taken it diminished rapidly. In April, from the 2nd to the 29th, the number of reported plague attacks declined to 2,438, and the deaths to 2,052. The total mortality, which had been 8,289 in the previous four weeks, was 4,871 in the four weeks ending 29th April. The decline was continued in the two following months. In the four weeks ending 27th May the total mortality was 2,700, and the reported plague mortality 514. Between 28th May and 1st July the figures were 2,496 and 200, respectively.

Bombay City. March to June 1898.

Bombay City. Municipal authorities resume charge of plague administration on 6th June 1898.

38. On the 6th June, the control of the plague operations was resumed by the Municipal authorities and the Plague Committee ceased to exist. The system pursued by the Municipal authorities provided for the division of the City into nine divisions, each under a District Officer, selected from the officers of the Indian Staff Corps and others on plague duty, who had a staff of doctors under him and was assisted by volunteer committees of native gentlemen. A case of plague having been reported, the Medical Officer went to the house and examined the patient. If he was satisfied that the case was one of plague, he wrote a certificate and sent the patient to the nearest hospital, except when the patient was, in his opinion, in a moribund state. This concession has lately been extended so that a certificate from a medical

25,555-25,561.

Mr. Du Boulay's evidence, Vol. III, pp. 305-310.

attendant, that a patient being attended by him cannot be removed without risk, exempts the patient from being taken to hospital. As soon as a case had been reported, the Contact Inspector visited the house, received a list of contacts from the medical officer, and sent them to a contact camp. They were required to keep in camp for ten nights, but were permitted to occupy themselves in their business during the daytime. The house was disinfected during their absence. A house in which a series of cases had occurred was evacuated. Any residents who had not been in contact with a plague case were sent to a health camp. There were a number of camps of this kind.

Third outbreak in Bombay City, Statistics from July 1898 to June 1899.

39. The mortality in Bombay City remained low in July 1898. In the four weeks ending 29th July the total mortality was 2,184, and the plague mortality 237. Then came a slight rise. The figures for the four weeks ending on 26th August were 2,858 and 444. The outbreak gained strength in September and the early part of October, and then began to decline again. From 27th August to 28th October (a period of nine weeks) there were 7,576 deaths of which 1,478 were reported to have been due to plague. In the following period of nine weeks, from 29th October to 30th December, the total mortality was 6,130 and the plague deaths 695. But the mortality had begun to increase seriously in the latter part of December, and with the beginning of the new year the outbreak rapidly became more serious. The following figures show the general mortality and the mortality from plague in the three succeeding periods of four weeks:—

Date.	Average Mortality.	Total Mortality.	Reported Plague Mortality.
31 December 1898 to 27 January 1899 -	2,025	4,975	1,298
28 January to 24 February 1899 - -	2,190	7,250	2,813
25 February to 24 March 1899 - - -	2,160	9,394	4,252

In the last week in March 1899 the mortality began to decline, and the decline was maintained, as the following figures show, till at the end of June there were very few cases of plague:—

1899.	Average Mortality.	Total Mortality.	Reported Plague Mortality.
25 March to 21 April - - -	2,327	7,154	2,788
22 April to 19 May - - - -	2,421	4,333	1,249
19 May to 16 June - - - -	2,109	2,623	359
17 June to 30 June (fortnight) - -	957	1,073	88

Mortality recorded in Bombay City from plague and from all causes from January 1897 to June 1899.

40. Taking the figures of total mortality and recorded plague mortality in Bombay City for a period of two-and-a-half years, from the beginning of January 1897 to the 30th June 1899, we find the following results. The total mortality in the whole period has been:—

January to December 1897 - - - - -	49,128
January to December 1898 - - - - - -	53,409
January to June 1899 - - - - -	36,802
Total - - - -	139,339

The recorded plague mortality has been 41,194. The normal mortality in this period would be just about 69,000. The actual mortality has exceeded the normal mortality by about 70,400. It appears practically certain that at least 30,000 deaths, and probably more since the population was at different times far below the normal number, due to plague have been attributed to other causes. Assuming that the excess mortality in the two-and-a-half years had been due to plague, the mortality from plague in a population of 850,000 would be at the rate of 8·3 per cent. in the whole period, or about 3·4 per cent. per annum. Even if reasonable allowance be made for the extent to which the population has been below the normal number at different periods during the epidemics, the mortality must be considered remarkably low in a city which has suffered without interruption for so long.

26,719. In the three periods of six months, from January to June (which includes the period in which the epidemic was at its worst in each season), the normal mortality, the actual mortality, and the plague mortality, contrast as follows:—

Date.		Normal Mortality. (a.)	Total Mortality. (b.)	Plague Mortality. (c.)	Difference between (a.) + (c.) and (b.)
1st January to 30th June, 1897	-	13,700	28,350	8,950	5,700
„ „ 1898	-	13,700	34,700	15,250	5,750
„ „ 1899	-	13,700	36,800	12,850	10,250

III.—(b.) *History of the Plague, to the end of June* 1899, *in the Bombay Presidency, outside Bombay City.*

III.—(b.) (1.) *History of the Outbreaks in Sind in* 1896–7.

Plague in the Bombay Presidency, outside Bombay City, 1896–7.

41. In October and November 1896, isolated imported cases were detected from time to time at different places in the Bombay Presidency, but no important local infection was discovered during these two months.

First outbreak in Karachi City 1896–7.

11,093. The first place outside Bombay City to be seriously attacked was Karachi City (population 105,200), which stands on the shore of a bay of the Indian Ocean at the extreme northern end of the Indian delta. It is in constant communication with Bombay. Plague was discovered here on the 10th December 1896. The mortality in the City during October November and December in 1896, taken either daily, weekly, or monthly, showed no indication of the presence of plague. The imported cases usually discovered before a local outbreak are wanting in the history of the introduction of plague into Karachi.

Manner of introduction of plague into Karachi not traced.

11,093; 11,846. The first case of plague that was detected in the City came to the notice of the authorities on the 10th of December 1896, the patient having apparently been taken ill about the 6th of December. It is doubtful whether this is the first case that actually occurred in Karachi, for on the 11th of December another case of plague was found in the immediate neighbourhood, and no connexion could be traced between the two cases. Subsequently others were discovered in gradually increasing numbers. The man whose illness was discovered on the 10th of December was a Hindu cook, who was a resident of Karachi and does not appear to have come into any personal communication with people from Bombay. He, however, lived in Rampart Road, which was "inhabited by merchants who have a great deal to do with Bombay," and it was the general idea that the source of his infection came from Bombay, which was in constant communication by sea with Karachi. As precautions were taken to prevent the importation of infection by means of infected persons or clothes, rats and cargo have been suggested as the probable means by which the infection was carried. In the absence of any facts, however, it is unwise to adopt this or any other theory as to the mode by which the infection was conveyed to Karachi.

Course of first epidemic at Karachi, and measures adopted.

The epidemic reached its height in the second week of February 1897; it began to decline in the middle of March, but it did not stop till the end of July. The recorded plague mortality during the outbreak was:—

December 1896	- - - - - -	59
January 1897	- - - - -	743
February (1st to 26th) 1897	- - - -	939
27th February to 2nd April 1897	- - -	979
3rd to 30th April 1897	- - - -	485
1st to 28th May ,,	- - - -	150
29th May to 2nd July 1897	- - - -	38
3rd to 30th July 1897	- - - -	9

The recorded mortality of 3,402 falls at the rate of 3·2 per cent. of the census population. In the early stages of the outbreak, the sick were not compelled to go to hospital. The people were invited to send their sick to hospital, but few did so. It was only in cases in which the sick were moved from affected to non-affected areas that removal to hospital was insisted on. 11,105. The disease spread very slowly. In January, people were encouraged to leave Karachi, and about 25,000 did so. 11,133. About six weeks after the discovery of the first case, a group of about 2,000 people from the part of the town where plague was worst were removed into camp across the Lyari, a river which flows to the west of the main portion of the town and has, for the greater part of the year, practically a dry bed. They took their sick with them, and were permitted to go daily to their business in the City. A good many cases occurred among them. They remained in camp until July. Following their example, a number of the other inhabitants of the town went out into camps. By the middle of February it had become the practice to remove the healthy people from infected houses to regular segregation camps; and, in March, this practice was extended to the inhabitants of 11,142. neighbouring houses. On the 20th of March the operations were placed in charge of a 11,149. Plague Committee. House to house searches were resorted to, stricter measures were taken for guarding people in the segregation camps, and the clothes of all entering or leaving the segregation camps were disinfected.

When the first epidemic died out at Karachi, strict precautions were taken to protect 12,151; 12,317-9. the City from re-infection by sea. Persons arriving by sea from infected places were detained under observation for 10 days, the crews of ships from infected ports were not allowed to land, and measures were taken to prevent native boats from infected places going alongside the Native Jetty, where they usually load and unload, or from communicating with the shore until they had undergone 10 days' quarantine.

Sind outside Karachi City.

42. As the outbreak in Karachi City led directly to outbreaks in the three districts of Karachi, Hyderabad, and Shikarpur, it will be convenient to refer to them here before proceeding to other outbreaks in the Bombay Presidency proper. In the Karachi district itself there were only 234 cases (60 indigenous) and 174 deaths (45 indigenous). But the disease became more prevalent at places at a greater distance from Karachi.

Outbreak at Hyderabad in Sind 1897.

The town of Hyderabad (population 58,000 at the time of the Census, and now estimated at about 65,000) became infected from Karachi at the end of February. Thirty-five imported cases were discovered before the disease became indigenous. There was 18,115. not a large exodus from the place. 18,087. House to house inspection was resorted to in order to discover cases. About three-quarters of the population were removed from their houses. They were allowed to re-enter the town daily for business purposes. The sick were taken to hospital, and the healthy inmates of infected houses segregated. The spread of plague was slow till the beginning of April when there were 148 indigenous cases in the week ending on the 16th, immediately before and after which more than 80 cases were recorded each week. It then declined and the epidemic had died out by the beginning of June. The reported cases were 536, and the deaths 405. The attacks were at the rate of a little over ·8 per cent. of the census population. In the district of Hyderabad, outside the town, there were only 21 cases and 18 deaths.

Outbreak at Sukkur, 1897.

The Shikarpur district is in the extreme north of Sind. The towns of Sukkur (population 29,300) and Rohri (population 9,000) are in this district, and are separated from each other by the Indus at a point where the railway crosses it. 3,723. The first indigenous case of plague occurred in Sukkur on 12th February 1897. There is no record of any imported case having preceded it. There was no great amount of plague till towards the end of March, but in the five weeks ending 16th April, 423 cases were reported. The disease then declined and the last case was on 2nd June. The number of attacks was 537, and the deaths 392. The attacks were at the rate of 1·8 per cent. of the census population. About 10,000 people left the town. The worst infected quarter of the town was evacuated.

Account of Plague Administration in Bombay Presidency from September 1896 till May 1897, by Mr. Couchman, I.C.S., pp. 172-3.

Outbreak at Rohri, 1897.

Rohri was infected in the second half of April. Twenty-two cases were imported into Rohri from Sukkur, the first at the end of February. Plague in an indigenous form was reported on 17th April. 12,024. Half the population had then left the town. As cases occurred the blocks of houses in the neighbourhood were evacuated, the people taken for ten days out of their houses, 12,039. and the houses disinfected both at the time when they were emptied and when they were re-occupied. The largest number of people taken out at any one time was 150. The infection was not serious. The epidemic declined from the middle of May and disappeared before the end of June. 12,043-4. There were 151 cases and 92 deaths. The attacks were at the rate of 1·6 of the census population of the town.

The disease spread to two villages on the north of Rohri, close to the frontier of the 12,083-7. Punjab. The people were removed from their houses, and the outbreak ceased without the infection being carried across the border.

During the outbreak in Karachi and the rest of Sind up to June 1897, 6,016 cases and 4,746 deaths were reported. During an epidemic of cholera in 1892, the three districts which were infected with plague in 1897 lost 14,659 persons by cholera.

III.—(*b.*) (2.) *Course of the Plague in the Bombay Presidency in December* 1896 *and January* 1897.

Bombay Presidency, December 1896 and January 1897.

43. Some places of the Bombay Presidency proper had become infected soon after Karachi. Towards the end of December 1896, plague moved into the Thana district, which adjoins the town and island of Bombay. Ninety-seven cases were reported from the district in that month, and 359 in January; the towns of Bandra (population 18,300) and Bhiwandi (population 14,400) were attacked in December, the towns of Kurla (population 11,500) and Thana (population 17,500) being attacked in January. Seventy-four cases, chiefly imported, occurred in the Ratnagiri district in January. Cases also occurred in Kolaba and Satara, and a few in other districts.

First outbreak at Poona City and Cantonments, 1896–7.

A number of imported cases had also been discovered in December, 1896, at Poona, the chief town of the Poona district, between which and Bombay there is very close communication. At the end of the month two local cases occurred in the town. The population of the town proper, ascertained at the census of 1891, was 118,790, that of the suburban area, 7,506, and that of the Cantonment, 35,094. The area on which this population (161,390 in all) is collected, extends over about 13 square miles. By the end of January, 1897, plague had taken a firm hold on the City, and it became much worse in February. It was determined to employ the agency of troops in dealing with the outbreak. At the beginning of March a Plague Committee was appointed to control the measures for its suppression. These measures, which provided for the detection of plague cases by means of search parties, the compulsory removal of plague patients to hospital, the removal to segregation camps of healthy persons who had been exposed to plague infection, and the disinfection of houses and of movable property which had been exposed to infection, were of a more stringent character than had been attempted elsewhere up to this time. At one time the number of troops employed on plague duty was 1,112.

Page 34 and App. 53 of Mr. Rand's Report attached to the account of Plague Administration in the Bombay Presidency from September 1896 to May 1897, prepared by M. E. Couchman, I.C.S.

The measures undertaken met with great opposition. On 22nd June Mr. Rand, the Magistrate and Chairman of the Plague Committee, and Lieutenant Ayerst, who was mistaken for another officer employed on plague duty, were murdered.

The outbreak was at its worst in the middle of March and the mortality remained high till the middle of April, when it declined rapidly. By the end of May it was practically over and only isolated cases occurred in the two following months. The recorded attacks and deaths from plague, the total mortality, and the normal mortality, are compared, for the period up to 20th May, in the following table compiled from statements printed in Mr. Rand's Report, the figures being the totals for the City, the suburbs, and the Cantonments taken together:—

Date.	Plague Attacks.	Plague Deaths.	Normal Mortality	Total Mortality.
December 1896 - - - -	49	37	364	388
January 1897 - - - -	193	150	358	657
February 1897 - - - -	271	211	304	1,114
March 1897 - - - -	1,198	816	339	1,842
April 1897 - - - - -	718	497	363	853
May to 20th - - - -	76	58	237	200
Total - - -	2,505	1,769	1,965	5,054

Towards the close of the epidemic the difference between the actual and the normal mortality is more than accounted for by the mortality recorded from plague. But this was not the case in the early stages of the outbreak, and while the epidemic was at its height. Considering that the population was below the normal strength, it is reasonable to infer that the difference between the actual and normal mortality during the epidemic, viz., 3,089, more nearly represents the actual mortality from plague than does the recorded plague mortality of 1,769. In the City alone the normal mortality should have been 1,435 and the actual number of deaths exceeded this figure by 2,787, which represents a death-rate of 2·3 per cent. on the census population of the City proper; the number of recorded deaths in the City was 1,481, which is 1·2 per cent. of its census population.

III.—(*b.*) (3.) *Course of the Plague in the Bombay Presidency in February* 1897.

Bombay Presidency, February 1897.

44. In February, up to the 26th, there were 979 cases in the Thana district (in which the infection spread to the town of Bassein, of which the population amounts to about

11,300), 97 in Ratnagiri, and 53 in Satara. The Surat (117 cases), and Kolaba districts (82 cases), Kolhapur (8 cases), and parts of Kathiawar (51 cases), became infected.

First outbreak at Surat, 1897. 15,856. 15,562. 15,626.

Some indigenous cases occurred in the town of Surat (population 108,700) at the end of the month. There appear to have been more than one source of infection, but one, at all events, seems to have come from Rander, a neighbouring town. Thirty-three imported cases were detected before any indigenous case was reported. The infection of the town on this occasion was very slight, and when plague ceased on 11th May, there had only been 49 imported and 65 indigenous cases. The sick were sent to hospital and their relatives segregated. The infected houses were emptied, limewashed, and their tiles taken off.

First outbreak at Bulsar, 1897.

The town of Bulsar in the Surat district (population 13,000) was attacked with indigenous plague in February, after six cases had been imported from Bombay. An epidemic then broke out which lasted till the end of June 1897. The number of reported indigenous cases was 902 (6·9 per cent. of the population).

III.—(*b.*) (4.) *Course of the Plague in the Bombay Presidency in March* 1897.

Bombay Presidency, March 1897.

45. From the 27th of February to the 2nd of April, 1,859 cases were reported from the Thana district, where the outbreak reached its height at the end of the month, 940 from the Surat district, 131 from the Poona district excluding the City, 186 from the Kolaba district, 98 from Ratnagiri, and 53 from Kathiawar. Fresh centres of infection were discovered in the Naosari division of the Baroda State (103 cases), in Palanpur, the capital of the Palanpur State (85 cases), and in the Cutch State (83 cases).

First outbreak at Palanpur, 1897. 13,054. 13,159.

The town of Palanpur (population 21,000) was infected in February 1897 by a trader who had been to Bombay. The epidemic was not serious, but the reported cases (141 between February and 15th May 1897 when the outbreak ceased) understate its actual extent.

First outbreak at Cutch Mandvi, 1897. 13,360, *sqq.* 13,384–5. 13,374–7. 13,378–9.

Indigenous plague occurred in Cutch Mandvi, a walled town of 38,000 inhabitants, which is the chief port of the Cutch State, and is situate between Karachi and Bombay. It is in frequent communication with both of these places. It appears that the actual source of infection was Karachi. Cases were not reported to the Political Agent till the middle of April 1897, when the town was already badly infected. In the early part of the outbreak there were no arrangements for dealing with the disease. By the end of April hospitals had been started and measures taken to segregate contacts. The outbreak was a virulent one, particularly at the end of April and in the beginning of May. After the climax had been reached in the first week of May the disease gradually declined, and was practically over early in July. Plague lingered on, however, till 13th August. The number of attacks is given by the State authorities as 4,298, and the number of deaths as 4,224, but neither of these figures has any claim to be accurate. Calculated upon them the rate of mortality per cent. of the census population was over 11, but it was, undoubtedly, much higher. All deaths ascertained at the burning or burial grounds were treated as due to plague, and the people were removed from the infected house and allowed to camp out where they liked. About 20,000 persons left the city and went into camp.

From Cutch Mandvi plague spread to the interior of the Cutch State in which twenty-four places were infected.

Outbreak at Daman, 1897. 16,343, *sqq.* 16,385. 16,438, 16,486. 27,214. 27,229.

About the beginning of March 1897, plague began also in Daman, a small Portuguese settlement situated on the coast between Bombay and Surat. The town is divided by a stream into Upper Daman (population 5,000) and Lower Daman (population 7,000). During this outbreak plague was confined to Lower Daman. There was no record of mortality, but it is estimated that 2,000 persons (16·6 per cent. of the population of the whole of the town) perished between the outbreak of the plague and its cessation at the beginning of July. Practically no measures were taken to arrest the progress of the disease.

III.—(*b.*) (5.) *Course of the Plague in the Bombay Presidency in April* 1897.

Bombay Presidency, April 1897.

46. From the 3rd of April to the end of the month there was a slight improvement in the Thana district, but 1,201 cases were reported from it. From the Surat district 784 cases were reported. The outbreak in this district reached its highest point in the middle of the month and then began to decline. In the Kolaba district there were 568 cases. In the Cutch State, including the town of Cutch Mandvi, there were 601 cases, and in the Baroda State 245. From the Palanpur State 54 cases were

returned. The outbreak there was over by the middle of the month. Seventy cases were returned from the Poona district excluding the City, 51 from the Ratnagiri district, and 64 from Kathiawar.

III.—(*b.*) (6.) *Course of the Plague in the Bombay Presidency in May* 1897.

Bombay Presidency, May 1897.

47. In May there was a general improvement, except in the Cutch State. The returns from that State for the period from the 1st May to the 4th June showed 3,482 cases altogether, of which 3,403 were indigenous cases in the town of Cutch Mandvi, and 23 indigenous cases in other parts of the State, the rest of the cases being imported. The cases reported from the Thana and Surat districts fell to 416 and 138 respectively. In the Thana district the disease died out in Bandra and Bhiwandi in the beginning and middle of the month, after the total number of indigenous deaths from plague in these towns had reached 711 in the case of the former, and 432 in the case of the latter. The towns of Thana and Kurla became free of plague about the end of the month, the total number of indigenous deaths reported having been 90 in Thana, and 366 in Kurla. Three hundred and fifty-six cases were reported from the Kolaba district, and 272 from the neighbouring State of Janjira, of which almost all occurred in the town of Murud which had become infected towards the end of March and reported 38 cases in April. One hundred and thirty-two cases were reported from the Baroda State, and 68 from Kathiawar. Plague was present in a few other districts, but to a very unimportant extent.

III.—(*b.*) (7.) *Course of the Plague in the Bombay Presidency in June* 1897.

Bombay Presidency, June 1897.

48. In June matters still further improved. From the 5th of June to the 2nd of July 912 cases were reported in the Bombay Presidency and connected Native States, including 157 which occurred in Bombay City. In this period of five weeks 566 cases occurred in the Cutch State, of which 324 were indigenous cases in the town of Cutch Mandvi and 232 indigenous cases in other parts of the State, where Gundiali and Maska were chiefly infected. Of the 189 cases returned from the rest of the Presidency, 35 occurred in the Kolaba, and 36 in the Thana district, where the outbreak in Bassein came to an end after 351 indigenous deaths had occurred in the town.

III.—(*b.*) (8.) *Course of the Plague in the Bombay Presidency in July* 1897.

Bombay Presidency, July 1897.

49. Though only 644 cases were reported during July 1897 from the 3rd to the 30th of the month, including 52 in Bombay City, the increase in the number of cases as the month advanced pointed to the likelihood of a fresh outbreak. One hundred and twelve cases were reported from the villages in the Poona district.

Outbreak in Poona and Kirki Cantonments, 1897.

The Cantonment of Poona also had become infected on 27th June 1897. Plague first
broke out among the followers in the Native cavalry lines. The lines were vacated on
6th July, and ultimately, as cases continued, the regiment went into a camp in the neigh-
bourhood but was moved into camp across the river on 15th September. On 12th July
21,193. four cases were found in the neighbouring Cantonment of Kirki (population 11,000).
21,208. Dropping cases continued till 31st July when the disease became epidemic. On the
21,247. 7th August, cases appeared in the Royal Artillery followers' lines contiguous to the Kirki
Bazar. The occupants were moved out and the lines disinfected. On 9th August, a
case imported from Kirki was discovered in the Poona Cantonment, and thereafter
other cases occurred. From 25th August, a rigorous system of search parties was
introduced. The sick, on discovery, were sent to hospital, the whole of the
inhabitants of the house segregated, and the house immediately disinfected. The
people were allowed to return to their houses after ten days. Plague ceased to be
21,222. epidemic in the Cantonment of Kirki in the middle of September, and was practically
over by the end of the month. At about the same time the epidemic became virulent
21,251. in the Cantonment of Poona. In September and October it attacked the native troops
21,259. and their followers. A Plague Committee, consisting of the late Major-General Duncan,
21,221. Lieut.-Colonel Fawcett, R.A.M.C., and Major Ross was appointed in November. The
whole Cantonment was then searched daily. Plague ceased to be indigenous at the end of
December, but it did not stop finally till 11th March 1898. The population,
nominally about 35,000, dwindled during the epidemic to about 12,000. The
21,314, 21,316. number of cases reported in the Poona Cantonment was 422, and the deaths 298. In
Kirki, the outbreak, though it lasted a shorter time, was more severe. There were

690 cases and 561 deaths in Kirki. The rate of attacks was 6·3 per cent. of the census population.

The number of cases reported during July in the Surat district was 60. Plague **Second outbreak**
broke out again in the town of Surat in that month. One case occurred on **at Surat, 1897.**
4th July, but until 30th July no further cases were reported. The mortality **15,729.**
did not rise above the average until August. From 15th August till the beginning **15,737.**
of the following May, cases occurred continuously. Between 28th July 1897, and
3rd May 1898, the mortality exceeded the average mortality by 4,154. The reported
plague cases were 2,551, and the deaths 1,737. The outbreak was at its worst in **15,728.**
October and November. In this outbreak, people suffering from plague were **15,715.**
taken to hospital, each patient with one attendant. All the inmates of a plague-infected
house were removed to the segregation camp, and those of the neighbouring houses **15,734.**
to health camps. As soon as the rains permitted, this course—the general evacuation of infected localities—was enforced. At one time nearly 17,000 persons were in camps. Under the system adopted the whole of a locality where more than one case occurred within a short time, or where plague was found to be persistent, was evacuated. All uncertificated deaths were treated as plague deaths, and the inmates of houses in which an uncertificated death occurred were segregated. It would appear, however, that many cases due to plague must have been certified as due to other causes. The infected houses were disinfected with perchloride of mercury, and afterwards lime-washed, and light and air was, if necessary, admitted. The incidence of reported cases per cent. of the census population was 2·3, but the number of cases that occurred must have been far beyond the number reported.

One hundred and fifty-one cases were returned from the Satara district in July 1897. **Outbreak at**
The seat of infection here was the town of Karad (population 12,000). Many people **Karad, 1897.**
from this part of the country are employed in Bombay as porters or on similar work. **21,060.**
Plague was not notified at Karad till 7th July, when it had clearly been present for at least two months. Plague was discovered when the rains were very heavy, and it was impossible to evacuate the town. The sick, and those in contact with them, were isolated, and the infected houses and their contents disinfected. These
measures were begun at the end of July, and improved in September. Plague continued **21,090.**
till the beginning of December. The number of cases reported during the outbreak was 1,517, and the deaths 1,153. The rate of attack per cent. of the population was 12·5.

A few cases were reported during July in the Kolaba district (23), and the Cutch (129) and Baroda (53) States. Karachi City was very slightly infected, but the rest of Sind was free.

III.—(*b.*) (9.) *Course of the Plague in the Bombay Presidency in August* 1897.

50. In August, in the five weeks beginning on the 31st July and ending on the **Bombay**
3rd September, there was a sharp increase in the returns from the Satara (1,421), and **Presidency,**
Poona (934), districts. The infection in the Satara district was still centred in the **August 1897.**
town of Karad. Two hundred and eighty cases were reported from the Cutch State.

The City of Poona was re-infected in August, it is supposed from the neighbouring **Second outbreak**
Cantonment of Kirki. The second epidemic in the City became very severe in October **in Poona City,**
and November, and reached its climax in the second week in December. After that **1897-8.**
there was a continuous fall until the City became free at the end of February 1898. **21,681.**
The measures taken during the second were less stringent than those taken in the first **21,684.**
epidemic. Endeavours were made to work with the co-operation of the people by means of **21,694.**
a system of employing volunteers, and this resulted in better information being obtained.
The system of segregation was made less strict. The number of cases reported in **21,685.**
this epidemic was 4,644, and of deaths 3,633. The population in the City during
this outbreak was much reduced. It is estimated that it fell to not more than 80,000. **21,782.**
Calculated on the normal population of the City proper, the ratio per cent. of attacks is 3·9, and on the population actually assumed to be present 5·8 per cent.

The Nasik district also became infected in August at Igatpuri. This is a town of **Outbreak at**
7,500 inhabitants, which has grown up on the Western Ghats, whence the Great Indian **Igatpuri, 1897**
Peninsula Railway descends into the Konkan. It consists almost entirely of people in the
employment of the railway company. It was infected from either Bombay or Poona. **16,884.**
The place has a very high rainfall, and, on account of heavy rains, it was impossible to
evacuate it. All that could be done was to put the sick into hospital, to clean up and **23,196.**
disinfect houses that had been vacated by their owners and to place in them the people
from infected houses, to disinfect infected houses and allow the inmates to reoccupy **19,493.**
them at once, and eventually to evacuate infected localities by accommodating the

people in waggons supplied by the railway company. The epidemic here lasted 13 weeks, during which time there were 512 cases and 411 deaths. The incidence of attacks amounted to 6·8 per cent. of the population. From Igatpuri plague was taken to other places in the Nasik district.

During August a few cases were returned from the Thana (56, chiefly from Kalyan, which has a population of about 12,500), Kolaba (13), and Surat (48), districts, the Palanpur State (61), and the Baroda State (15).

III.—(*b.*) (10.) *Course of the Plague in the Bombay Presidency in September* 1897.

Bombay Presidency September 1897.

51. In September the outbreak became very serious in the Poona (759 cases), and Satara (1,960 cases), districts. The figures here given for this month refer to the period from the 4th of September to the 1st of October. In the City of Poona reported cases rose to 354. The returns from the Cutch State showed 501 cases, the Nasik district had 304 cases (chiefly at Igatpuri), the Surat district 182, the Thana district 86 (Kalyan remaining the chief centre of infection), and the Kolaba district 83. There were a few cases in the Baroda State (35), and in the districts of Ahmednagar (37), Sholapur, and Ratnagiri.

Second outbreak at Palanpur, 1897.

13,059–60.

Two hundred and fifty-four cases were reported from the Palanpur State. The first outbreak in Palanpur City had ceased in May 1897. In the beginning of August 1897 plague reappeared in the quarter of the town which had been previously infected. The first case was again that of a trader who had returned from Bombay three days before he was attacked. About one-third of the people left the town. Search parties were utilized to find cases. Patients were sent to hospital, and their relatives and those living in adjacent houses segregated. The disease began to decline towards the end of September, but many of the people who had left the town came back then for a festival. An immediate increase in the number of cases resulted. The inhabitants of the town (then 13,000) were on 2nd November turned out of it. The whole town was then disinfected. The people were allowed to return on 15th December. Seven or eight imported cases occurred afterwards, but no indigenous cases. The number of cases reported during the epidemic was 674. The ratio of attacks per cent. of the normal population is 3·2, but the population present during the epidemic was never nearly as high as the ordinary population.

13,080

13,159.

III.—(*b.*) (11.) *Course of the Plague in the Bombay Presidency in October* 1897.

Bombay Presidency, October 1897.

52. In October, from the 2nd to the 29th, the outbreak gathered force in the Satara district (3,506 cases), especially in the villages in the Karad taluka; an outbreak also began in the town of Tasgaon (population 11,300) in the Tasgaon taluka, where one or two other places also were severely attacked. Plague spread to the Aundh State in the neighbourhood of the Satara district in August, and up to the 29th October about 120 cases occurred in the State, of which about 50 took place in the town of Aundh. In the villages in the Poona district there was a substantial decline, the cases returned amounting to 517, compared with 759 in previous five weeks. On the other hand the outbreak became very severe in Poona City (1,380 cases). The number of cases reported from the Cutch State (471) and the Thana (62) and Kolaba districts (41) was slightly less than in the previous month. In the Surat district 369 cases were reported in October, mainly in the town of Surat. In the Palanpur State (244 cases) the outbreak was stationary, and there was very little plague in the Baroda State (37 cases). The plague had died out in Ratnagiri. The cases returned from Nasik district fell to 191, but Nasik town became infected from Igatpuri during the month.

First outbreak at Nasik, 1897–8.

16,918–46.

Nasik is a town of 24.500 inhabitants, in which several imported cases had been discovered between March 1897 and 12th October 1897, when the first indigenous case was found. At the beginning of the outbreak only the occupants of infected houses were removed, and the houses disinfected. The next step was to remove the residents of neighbouring houses. In the middle of November the town was divided into wards, and the wards gradually evacuated as they became infected. Eventually (by the beginning of January 1898) the whole town on the south of the Godavari river was emptied. Plague did not stop till 25th March 1898, nearly five-and-a-half months after it was discovered. There were 450 cases during the outbreak (1·8 per cent. of the population).

16,937.

Outbreak at Sholapur. 1897–8.

23,888 *sqq.*

20,230 *sqq.*

In the Sholapur district (from which 170 cases were reported) the epidemic was confined to the town of Sholapur (population 62,000). The infection was apparently brought from Poona; the outbreak began in a suburb half a mile outside the town in September. A cordon was drawn round this suburb, but this endeavour to isolate the people was a complete failure, and in October the town itself was attacked. On the 15th of November the infected suburb was evacuated, and plague ceased among the inhabitants of it in a fortnight. In the town a beginning was made by evacuating the worst quarters, and by the end of November four quarters containing 400 houses had been evacuated. The plague still spread, and at the beginning of December it was determined to evacuate the whole town. After the town had been emptied the camps, which were occupied by 25,000 to 30,000 persons, enjoyed almost complete immunity from plague. The sick were taken to hospital, and people exposed to infection to the contact camps. The number of cases reported, during the epidemic, which ceased early in February, was 2,628. The incidence of reported attacks per cent. of the population was 4·2.

20,244, 23,903.

20,233, 23,932.

Outbreak in Ahmednagar Cantonment, 1897–8.
24,131–3.

In the Ahmednagar district 138 cases were reported from the Ahmednagar Cantonment and one other place. The first case detected in the Cantonment was reported on 27th September 1897. The infection apparently came from Poona. Different parts of the Cantonment were evacuated, the first on 8th October 1897, and the last in the beginning of December. The people were allowed to return on 19th March 1898, after the houses had been disinfected and whitewashed, and, except in one quarter, also unroofed.

Outbreak in Ahmednagar Town, 1897–8.
24,227.
24,237–8

The infection reached the City of Ahmednagar (population 36,000), apparently from the Cantonment, at the end of October, and the last case occurred on 21st March 1898. The usual steps were taken to send patients to hospital. The residents of the infected house, and of a certain number of houses on each side, were taken to the contact camp, and the houses disinfected. As these measures were ineffective, it was decided to evacuate whole wards at a time, and ultimately the whole City was evacuated by the middle of March, about 16,000 people having left the place and about 20,000 being in the camps outside. The number of reported indigenous cases in the outbreak was 407, of which 315 were fatal. The rate of attack per cent. of the population was 1·1.

24,358–9.

III.—(*b.*) (12.) *Course of the Plague in the Bombay Presidency in November* 1897.

Bombay Presidency, November 1897.

53. In November the returns from the Satara district were worse than ever and from the 30th of October to the 3rd of December, 4,788 cases were reported. Plague had appeared in 84 places in this district. There were 251 indigenous cases in the Aundh State.

Outbreak in Satara Town 1897–8.

A few cases occurred in Satara City (population 25,700) in October and November, but the outbreak did not become serious till the middle of December. The usual measures were taken with the sick and contacts, but there was no general evacuation of the town. The outbreak lasted till April 1st. There were 873 cases and 727 deaths. The rate of attack was at about 3 per cent. of the census population.

22,258.

The cases returned for the Poona district, in which 40 places were infected, had risen to 855. In addition to this, 2,805 cases were returned from the City of Poona. Owing to the large and rapid rise in Sholapur City, 1,357 cases were reported from the Sholapur district. From the Surat district 1,017 cases were reported, 370 from the Cutch State, and 168 from the Ahmednagar district.

Outbreak at Malegaon, 1897–8.
13,774.

Two hundred and ninety cases were reported from the Nasik district. The town of Malegaon (population 18,000) in this district became infected in November from Bombay. Blocks of the town were at first evacuated, disinfected, and whitewashed. Plague mortality, however, remained high, and in January 1898 the whole population was removed from the town. It took a fortnight to effect this evacuation, and within a month of its completion plague had ceased. There were 395 cases in all, with 314 deaths, a little under 2·2 per cent. of the census population having been attacked.

Outbreak at Belgaum, 1897–8.
23,023.

Two hundred and twenty-eight cases were returned from the Belgaum district, mainly from the Cantonment at Belgaum. Plague was imported into the Cantonment in September 1897 from Sirur, in the Poona district. It began in the City at the end of November. In this outbreak infected and neighbouring houses were evacuated, the sick sent to hospital, and those connected with them segregated. The houses were not allowed to be re-occupied till they had been disinfected, and were rarely re-occupied till a fortnight after they had been vacated. The outbreak was at its worst in January 1898, and continued till the second week in May. During this epidemic 762 indigenous cases were reported in the town and Cantonment. The population of the town and Cantonment is 41,400, but that of the town alone is about 30,700, and, as 432 indigenous cases were reported there, the rate of attack in the town, calculated on the normal population, was 1·4 per cent.

23,122.

In November there were 166 cases in Palanpur, 63 in Kolaba, 51 in Kolhapur, 38 in Thana, and 30 in the Baroda State.

The number of cases reported during October and November from the Karachi district was 19 and 57. An outbreak took place in the town of Kotri on the 28th October, and continued till the beginning of February 1898.

III.—(*b.*) (13.) *Course of the Plague in the Bombay Presidency in December* 1897.

Bombay Presidency, December 1897.

54. There was an improvement in the general position in December, particularly during the second half of the month. From the 3rd day of the month to the 31st, the outbreaks declined in the Satara district (1,604, cases) the Aundh State (194 cases), Poona City (1,403 cases), the Poona district (390 cases), and the Cutch State (132). In the Surat district also (654 cases), and especially in Surat town, there was a material decline in the number of attacks. As many as 1,238 cases were reported from the Sholapur district, almost entirely from the town, but by the close of the month the number of cases was rapidly falling there. On the other hand, matters became worse in the Nasik district (344 cases), in which Nasik and Malegaon were the places most infected; the Palanpur State (400), where the increase occurred among the villages; and in the Ahmednagar district (273), chiefly in Ahmednagar itself. The town and cantonment of Belgaum were mainly responsible for the 308 cases returned from the Belgaum district. The cases returned from the neighbouring State of Kolhapur rose to 72, and 37 cases were reported in the adjoining district of Dharwar also. The small town of Jalgaon (population 14,000), in the Khandesh district, adjoining the Central Provinces and the Hyderabad Assigned Districts, became infected, and 69 cases were reported from the district. The number of cases in the Thana district (67) increased owing to the infection of the town of Bassein; the town of Thana was also infected. Forty-six cases were reported from the Akalkot State, 39 from the Janjira State, 19 from the Kolaba district, and 16 from Kotri.

First outbreak at Baroda, 1897-8.

The number of cases reported from the State of Baroda rose from 30 in November
to 100 in December, owing to the increase of cases in Baroda City. This city, the
capital of the Baroda State, has a population of 112,500. A few indigenous cases 14,582, 15,584.
of plague occurred in it in April 1897, but there was no outbreak. During the rainy
season many persons came from Surat and other infected places, and the town became 14,596.
infected in October 1897. The isolation of the sick and the segregation of
contacts were undertaken from the beginning, and subsequently whole streets were
evacuated. In spite of these measures, and the disinfection of infected houses, plague
spread, and ultimately the whole town was evacuated in March 1898. Eleven thousand
persons were lodged in the camps maintained by the State, and about 40 000 persons 14,614.
went into the fields. Plague ceased in April 1898, and by the end of May the town 14,620, 14,677.
was nearly full again. Fifteen hundred and five cases were reported between the 14,628.
beginning of the outbreak and the end of May. The general mortality was very 14,637.
high, and doubtless many deaths due to plague were attributed to other causes. 14,983.
The rate of attack, calculated on the reported cases, and the normal population, which
was, however, much reduced, is 1·3 per cent., but the figure is quite unreliable.

III.—(*b.*) (14.) *Course of the Plague in the Bombay Presidency in January* 1898.

Bombay Presidency, January 1898.

55. The general improvement observed in December was maintained in January 1898. From the 1st January to the 4th February the number of cases in the Satara, Sholapur, and Poona, districts declined to 360, 605 and 154 respectively. In the middle of the month the outbreak at Tasgaon in the Satara district ceased, after causing 453 deaths. Four hundred and eighty-three cases were reported from Poona City. The Bhor State, in the neighbourhood of Poona, in which about 30 cases had occurred up to the end of 1897, reported 24 cases in January 1898. The cases returned from the Baroda State numbered 624, chiefly from Baroda City. The number reported from Nasik was 461 (mainly from Nasik and Malegaon), from the Surat district 807, and from the Belgaum district 427, chiefly from the City. Plague rose slightly in the Cutch State (264 cases), the Kolhapur State (245 cases), and the Kolaba district (95). The number of cases reported from the Thana district rose to 151, the infection spreading to Bandra during the month. Six hundred and fifty-one indigenous deaths took place in Bandra before the outbreak there came to an end in the latter part of May. Seventy-three cases were reported in Khandesh, where the infection was slight, and plague declined a little in the Palanpur State (258), and the Ahmednagar district (252 cases). The only cases reported from Sind were eight cases at Kotri.

III.—(*b.*) (15.) *Course of the Plague in the Bombay Presidency in February* 1898.

Bombay Presidency, February 1898.

56. Further improvement was reported in February. The figures given below cover the four weeks from the 5th February to the 4th March. The cases reported from the Satara district increased to 525; but in Poona City they declined to 113 cases, and in the rest of the Poona district to 86 cases. On the other hand, in the Surat district (878 cases) there was no improvement. The number of cases reported from the Baroda State was 1,036, mainly from Baroda City. An increase occurred in the Kolaba district to 158 cases. In the Sholapur district 424 cases were reported, almost entirely from the villages. In Kolhapur (chiefly in the Sangli State) there were 329 cases; in the Belgaum district 275 cases; in the Thana district 177 cases; in the Nasik district 203 cases; in the Ahmednagar district 140 cases; in the Palanpur State 103 cases; in the Cutch State 78 cases; in the Khandesh district 79 cases; in the Aundh State 50 cases; and in the Akalkot State 40 cases. No cases were returned from Sind.

III.—(*b.*) (16.) *Course of the Plague in the Bombay Presidency in March* 1898.

Bombay Presidency, March 1898

57. Between 4th March and 1st April there was again a substantial improvement. The number of cases reported from some places was large during this period, but in the majority of instances, and noticeably in the Surat district and the Baroda State, the outbreak was declining towards its close. Two hundred and eighty-eight cases occurred in the Surat district. These figures and those given for the district for previous months include figures for the Sachin State, in which 192 cases had occurred up to the beginning of April, 95 indigenous cases having occurred in March and 44 in February. From the Satara district, 324 cases were reported; from the Poona district, 84 cases (28 in the City); from the Baroda State, 844 cases; from the Thana district, 308 cases, the worst infected place in the district being Bassein; from the Kolaba district, 235 cases; from the Belgaum district, 221 cases; from Kolhapur, 326 cases; from the Khandesh district, 88 cases; from the Nasik district, 180 cases; from the Sholapur district, 96 cases; from the Ahmednagar district, 34 cases; from the Palanpur State, 157 cases; from the Cutch State, 45 cases; and from Kathiawar, 66 cases. One hundred and fifty-one cases occurred in Ratnagiri and a few cases in the Kaira, Dharwar, and Bijapur, districts.

Cause of second outbreak at Karachi not ascertained.

Nineteen cases were reported from Karachi City, which had been free from plague since July 1897. In investigating the cause of the second epidemic of plague in Karachi, and inquiring into the possibility of a re-importation of infection, the following circumstances must be considered. It is not impossible that the infection remained in the City without altogether dying out between the first epidemic and that which is now in question, for certain suspicious cases, that may have been cases of mild plague, were observed in the interval between the first and second epidemics. 11,599-612. In September 1897, one month after the close of the first epidemic, cases of enlarged cervical glands were observed, and at least one of these proved fatal. Later, and simultaneously with the outbreak of the second epidemic, a suspicious case of enlargement of the femoral glands was detected in a boy. Mr. Giles, the Commissioner in 11,183. Sind, however, was confident from the result of the inquiries which were instituted in the above cases, that Karachi was quite free from plague between the end of the first and the beginning of the second epidemic. This latter was ushered in by the discovery towards the end of March 1898 of two cases of plague, which apparently originated independently in the City. The first case was that of a Sikh carpenter, a resident of 11,512-6. Karachi, who lived in the Sarai quarter. The case, which was seen on the 22nd of March by Colonel McCloghry, I.M.S., occurred in a part of the town that had escaped infection in the first epidemic. The patient had apparently not visited any infected quarter, and the source of infection could not be traced. In view of the fact that the carpenter worked at the Native Jetty, it is surmised that he may have been infected by cargo landed there from Bombay. This inference, however, is not conclusive, for in the first place it is not certain that the carpenter's case was the first case of the second epidemic; again, dead rats appear to have been found before the case occurred; and 11,198. lastly, a severe outbreak, which was apparently quite unconnected with the case of the carpenter, broke out immediately after in the Joria Bazar, about half a 11,189. mile from the Native Jetty. It is in connexion with the outbreak in the Joria Bazar —an outbreak which marks the commencement of the second epidemic—that the second case spoken of above was discovered. No light has been thrown on the source of infection from which this epidemic originated. All that is certain with regard to

11,197; 11,338–44.
11,357–64.
817.

it is that it was preceded by great mortality among rats, and that infection first established itself in the bazar, which is occupied by retail grain sellers, who, though they have little personal communication with the harbour or the Native Jetty, deal in goods imported from Bombay. In view of this circumstance, the theory was mooted that the second epidemic of plague in Karachi was due to the importation of the infection in merchandise from Bombay. Nothing, however, has come to light which would warrant either the acceptance or the rejection of this theory.

Course of the second and third outbreaks at Karachi City. 1898–9.
11,260.

The second epidemic spread far more rapidly than the previous one. A special feature in the measures taken to deal with this outbreak was the establishment of the two health camps in the desert area across the Lyari river, which accommodated nearly 25,000 persons between them. The people were, after the middle of September 1898, allowed to leave the City with their sick for those camps, and were not detained in the ordinary segregation camps, provided that all cases of sickness were notified. 586 cases and 412 deaths were reported at Karachi in April up to the 29th. From the 30th April to the 3rd June the returns were 2,093 cases and 1,704 deaths. Towards the end of May matters improved, and in June, from the 3rd June to the 1st July, the cases fell to 294, and the deaths to 225. Cases, however, continued to occur, and by the end of December 1898 there had been 3,263 cases and 2,540 deaths. 27 attacks were recorded in the first five weeks of the year 1899, and cases began to get more numerous in February. In March the outbreak became very serious again, the number of cases reported from the 3rd to the 31st of the month being 767, and the deaths 513. The outbreak increased in severity in the early part of April, but began to decline during the second half of the month. There were 1,421 cases and 1,028 deaths between the 1st and 28th April, and in the next four weeks 646 cases and 501 deaths. In the last fortnight of June there were only three fresh cases and three deaths. From the date on which plague re-appeared, in March 1898, to the end of June 1899, the number of cases reported was 6,301, and the deaths 4,731. The attacks fall at the rate of nearly 6 per cent. of the census population.

III.—(*b.*) (17.) *Course of the Plague in the Bombay Presidency in April* 1898.

Bombay Presidency, April 1898.

58. Except at Karachi, where 69 imported cases occurred in the district in addition to the cases in the City, the outlook materially improved in April, and particularly in the second half of the month. Between the 2nd and the 29th of April, plague declined in the Satara (128 cases), Poona (13 cases), Surat (188 cases), Sholapur (30 cases), Nasik (33 cases), Khandesh (27 cases), Kolaba (104 cases), and Belgaum (147 cases), districts, and in the Baroda State (335 cases), the Palanpur State (41 cases), and the Cutch State (16 cases). In two districts, viz., Thana (381 cases), and Ratnagiri (197 cases), and in the Kolhapur State (357 cases), plague grew worse.

Second outbreak at Bulsar, 1898.
16,159, 16,160.

At the end of the month a second outbreak began in the town of Bulsar, which lasted till the following September. The infection was brought from Billimora in the Baroda State. The number of indigenous cases reported in this outbreak was 527. The attacks were at the rate of 4 per cent. of the census population.

III.—(*b.*) (18.) *Course of the Plague in the Bombay Presidency in May* 1898.

Bombay Presidency, May 1898.

59. From the 30th April to the 3rd June—five weeks—there were, outside the Cities of Bombay and Karachi, 1,872 cases, compared with 2,186 in four weeks of April.

Outbreak at Bhiwandi, 1898.
22,108.
22,119.
14,482.

The greatest number of cases (323) was returned from the Thana district. The town of Bhiwandi (population 14,400) in this district was re-infected in the middle of April. A severe epidemic began in it in June and lasted till the end of September. The population present in the town dwindled to 7,800. Nearly all the patients were treated in their own houses, a small minority of 153 consenting to go to hospital. All infected houses were disinfected when the sick persons resident in them had either died or recovered. The number of cases reported during this outbreak was 1,788. The reported attacks were at the rate of 12 per cent. on the normal population, and must have been at a far higher rate on the population actually present at different times during the epidemic.

The only other places in which there was plague to any appreciable extent were the districts of Surat (106 cases), Satara (141 cases), Belgaum (179 cases), Kolaba (40 cases), and the Baroda State (54 cases), Kolhapur (250 cases), the State of Porbandar in Kathiawar (47 cases), and the Cutch State (279 cases). In the Karachi district outside the City 318, for the most part imported, cases were reported.

Second and third outbreaks at Cutch Mandvi, 1898-9.
13,411.

The town of Cutch Mandvi had again become infected, and all the indigenous cases
but six returned during the month from the Cutch State occurred there. It is not
clear how the place became reinfected. There were about 12 indigenous cases in
January, February, and March, and 26 infected persons who arrived from Bombay
were detected and detained in the observation camps between the middle of January
and the beginning of April. Between the 2nd and 29th of April there were 10
indigenous cases. In the next five weeks, up to the 3rd June, there were 279 cases
and 195 deaths. Between 30,000 and 35,000 of the population were induced to go 13,424-5.
outside the walls of the town, leaving only 6,000 persons within them. There was a
considerable decline in the number of cases in June, but the outbreak continued till 13,414.
November, when it became very mild. Up to the middle of January 1899, 922 cases
and 748 deaths were reported. In February plague began to get worse. From the 4th to
the 31st of March there were 326 cases and 236 deaths, and in the five weeks ending
on 5th May 1,269 cases and 935 deaths. Between 5th and 26th May 378 cases were
reported, and then the outbreak declined till it died out entirely during the latter
half of June. Between the beginning of March 1898 and the end of June 1899
there were 2,678 cases and 2,011 deaths. The reported cases fall at the rate of 7 per
cent. on the population.

III.—(*b.*) (19.) *Course of the Plague in the Bombay Presidency in June* 1898.

Bombay Presidency, June 1898.

60. In June there was, generally speaking, an abatement of the disease during the earlier part of the month and an increase towards its close. Of 1,344 persons attacked during the month, from the 4th June to the 1st July, outside Bombay and Karachi Cities, 523 were attacked between the 5th and 17th, and 821 in the last fortnight of the month. The places chiefly affected were the Thana (232 cases) and Belgaum (264 cases) districts, Kolhapur (167 cases), the town of Hubli in Dharwar (102 cases), the Surat (112 cases) and Satara (98 cases) districts, the Cutch State (176 cases), and the Kathiawar State (87 cases) ; 32 cases occurred in the Karachi district.

III.—(*b.*) (20.) *Course of the Plague in the Bombay Presidency in July* 1898.

Bombay Presidency, July 1898.

61. The number of deaths from plague in the first week of July outside Bombay City was 457. The places most infected were the towns of Karachi and Cutch Mandvi, the Surat district to the north-west of Bombay, the Thana district (particularly the town of Bhiwandi) in the immediate neighbourhood of Bombay, the Satara district, the Kolhapur State, the Belgaum district, and the town of Hubli in the Dharwar district. As the month progressed plague became more virulent, particularly in the Kolhapur country, the Cantonment and district of Belgaum, and the town of Hubli.

Outbreak at Hubli. 1898.

The population of Hubli was 52,000 when the census was taken in 1891, but it has
probably increased by about 5,000. Plague first appeared in the town in indigenous
form in October 1897. Before that, in spite of the measures adopted to 1570
prevent the entry of the disease, at least one imported case came to the knowledge 1582.
of the authorities. This was the case of a woman who, on her return from 2396.
Bombay in February 1897, developed plague at Hubli in the chawls near the premises
which are occupied by railway employés. This case terminated in recovery, and
the infection did not spread. No further case occurred till October 1897. On the 2399.
15th of that month a suspicious case came to light in the railway chawls. This
case was diagnosed as plague on the 17th. The chawls were then cordoned with a
view to keeping the town free from the disease, and measures were taken to suppress
the outbreak in the chawls. These were ultimately successful, but in the meantime
the infection had been carried into the town. There would appear to be no doubt
that the cordon did not act as an effective bar to inter-communication. In particular, 2436-9; 20,151.
we are told that the relative of one of the police guards went to and slept in one of the
chawls and then returned to the town carrying the infection with him. The first case in
the town, which was detected about the 4th of November, was, as we were informed by
Dr. Cardoz, that of a man who was employed in the chawls. A similar history of a
connexion with the railway chawls was elicited in connexion with others of the earlier
cases in the town. It is noteworthy that only occasional cases occurred in the early
months of 1898, and that at the beginning of May 1898 the town was almost free from 1586-7.
plague. In spite of the measures adopted to check the spread of the infection—which
included the burning down of an infected street—plague, with the advent of the 2398.
rains, broke out in a very severe form. As in the case of the outbreak in
October, which was variously imputed to an importation from Sholapur on the one 20,141-2.

hand and from Poona on the other, nothing has been elicited to account for the outbreak of a severe epidemic in May. It was supposed by some observers that it was due to a re-importation of the infection—possibly to an importation in merchandise from Bombay. In favour of this view it was urged that the places which were attacked were nearest to the goods shed and that the cases occurred among people who worked on the railway premises. On the other hand, it was pointed out that, even if it was 20,170. necessary to assume a re-infection of the town (and plainly there is no necessity for making such an assumption), the re-infection of the town might quite well have been brought about by the arrival of infected persons from infected places in the neighbourhood.

The outbreak in Hubli which had become formidable in the middle of May, when heavy rain fell and interfered with the work of those employed in finding cases and with the other plague measures, gained strength till the end of August, when it began to decline. It ceased in the middle of November. The experiment of inoculating the population with Mr. Haffkine's vaccine on a large scale was made at Hubli, where 35,959 persons 25,151. had been twice inoculated and 5,157 once inoculated, by the 2nd December. The number of reported cases in Hubli was 3,388 with 2,946 deaths. The percentage of 1615. attacks on the normal population was just over 7. The attempt was made to keep a census of the average population present during the epidemic. Calculated on this, the 1598, 25,151. percentage of attacks was 8·6, and that of deaths 7·07.

Outbreak at Ankleshwar, 1898.

Plague broke out in an epidemic form in July at Ankleshwar (population 10,700) in the Broach district. Infection was imported from Chandod in Rewa Kantha in April 14,206–8. 1898, but only eight cases were reported in Ankleshwar before July. The outbreak 14,214. became severe at the end of that month, and was at its worst in August. The town was emptied by the 23rd of August. Plague continued till the beginning of November. Three hundred and thirty-one attacks and 245 deaths were reported. The attacks were at the rate of 3 per cent. on the census population, but it is to be noted that during the course of the epidemic many people left the town.

A few cases occurred in July in the Sholapur district, the Baroda State, and Kathiawar. None of these tracts was, however, seriously affected during the month. The Sachin State returned 147 cases; in the previous month there had been 54 cases, but the number fell to 17 in the succeeding month, and in all the State had 452 cases.

III.—(*b.*) (21.) *Course of the Plague in the Bombay Presidency in August* 1898.

Bombay Presidency, August 1898.

62. In August plague was very severe in the towns of Bhiwandi and Hubli. It remained severe in Surat and increased in Satara, and became virulent in the villages of the districts of Belgaum (2,565 cases from the 29th July to the 2nd September) and Dharwar (1,091 cases, excluding indigenous cases at Hubli). It reappeared in the Nasik district, particularly at Vinchur, and in the Akalkot State. It became worse in a few places in the Sholapur district, at Ankleshwar in the Broach district, in the Baroda, Cutch, and Kolhapur, States, and in the Bhor State near Poona.

Outbreak at Bantwa, 1898. 17,549 *sqq.*

An outbreak had begun at Bantwa, a small town of 8,200 in a native State in Kathiawar, at the end of July. The rains interfered with the measures taken. About 2,000 persons were removed from their houses in August. A storm took place which drove them all back to their houses. The population generally did not move out till between the 25th and 30th of September. Plague did not stop till the beginning of 17,552–5. November. The cases reported during the outbreak amounted to 944 and the deaths to 602. The incidence of attacks was a little over 11 per cent. of the population.

III.—(*b.*) (22.) *Course of the Plague in the Bombay Presidency in September* 1898.

Bombay Presidency, September 1898.

63. The outbreaks in the Belgaum and Dharwar districts grew worse in September. The number of cases reported from the former district from the 3rd to the 30th of the month was 3,605. In addition to the indigenous cases returned from Hubli and Dharwar towns, 5,913 cases were returned in September from the Dharwar district, the villages of which were badly infected by refugees from these two towns.

Second outbreak at Belgaum City, 1898–9.

Plague had begun to occur again in Belgaum City in July, and 120 cases were reported in August. The sick were treated at home during this epidemic. The people were not segregated, except for the time necessary to disinfect their houses. In 23,127. September the number of cases rose to 830. In October there were 1,304 cases, and from the middle of the month the number of cases declined. Plague continued during 23,128. November and December, but in January 1899 there were only 14 cases. From the beginning of July to the end of January, there were 2,721 cases and 2,025 deaths. 23,127-5. The attacks were at the rate of a little over 9 per cent. of the population.

Outbreak at Dharwar, 1898.

The town of Dharwar (population 26,600) began to be badly infected in the latter part of August, and 301 deaths among indigenous cases were reported in September. Here also, large numbers of the population were inoculated. The town was evacuated when the rains ceased. The epidemic ceased at the end of November, but a few cases continued for some time afterwards. Up to the beginning of December, 1,316 cases and 965 deaths 1,608. had been reported. The percentage of attacks on the normal population was about four. Here, as in Hubli, special efforts were made to keep a census of the population which remained present in the town. The incidence of attacks on the average population 25,151. during the epidemic is calculated at 6, and that of deaths at 4·4 per cent.

There was an increase in September in the number of cases reported from Kolhapur (1,854), and the Satara district (1,107), where Tasgaon was reinfected, though the outbreak that occurred was not serious, and, up to the middle of November when it ceased, was the cause of only 27 deaths. Six hundred and three cases were returned in September from the Nasik district, 611 from the Baroda State, and 270 from the Cutch State. The town of Umreth, in the Kaira district, was attacked; the infection 14,014, 14,020. apparently came from Savli in the Baroda State. The district of Poona became slightly infected, there were 237 cases in the Bhor State, and plague remained in a few places in the Sholapur district (89 cases). There was an improvement in the Surat (133 cases) and Thana (376 cases) districts. 155 cases occurred in the Broach district, chiefly at Ankleshwar.

III.—(b.) (23.) *Course of the Plague in the Bombay Presidency in October* 1898.

Bombay Presidency, October 1898.

64. In October, plague continued very severe in the Southern Mahratta country. Six thousand four hundred and seventy-one deaths were returned from the Dharwar district and 4,862 from the Belgaum district in the four weeks ending 28th October. There was a great improvement at Hubli town, where the number of cases reported was 128, and of deaths 124. In Dharwar town (657 cases), however, and Belgaum town (1,304 cases), plague continued severe. The mortality was also high in the Kolhapur country (2,243), and the Satara district (1,826). Out of 17,815 deaths reported outside the City of Bombay during the month, 15,403 were reported from the three British districts of Satara, Belgaum, and Dharwar, and from the Native States in the Kolhapur country.

The returns from the Poona district became worse (354 cases). The small towns of Ilkal (population 11,200), in the Bijapur district, and Kalol (population 4,500), in the Panch Mahals district, were attacked. A case or two occurred in the town of Ahmednagar. There was great improvement in the Surat and Thana districts and in Kathiawar. In the Thana district the epidemics in Bhiwandi and Bassein ceased, 274 indigenous deaths having occurred in Bassein since its infection in December 1897. The cases in Karachi dwindled to 18, and the deaths to 12. There were 566 cases in the Nasik district, 501 in the Baroda State, 250 in the Bhor State, 215 in Sholapur, 159 in the Cutch State, and 122 in the Aundh State.

Outbreak at Broach, 1898–9. 15,484.

The outbreak ceased in Ankleshwar, but the infection had been carried from it to Broach (population 40,000), by some butchers who came to reside with their friends at the latter place. The first case was found on 14th September, 1898. The quarter in which the butchers resided was evacuated and disinfected. Cases, however, spread in other parts of the town, and the mortality was very high in December. The practice was to send plague patients to hospital and the contacts to segregation camp, and to remove the neighbours to health camps. Special arrangements were made by the millowners for camps for those employed in the mills. About 18,000 persons left the town and either camped near 15,484, 15,502. the town or went to villages in the neighbourhood. There were altogether 36 indigenous cases with 24 deaths up to the 2nd December, the number of cases in October and November being nine and five respectively. In December there were 36 cases, and the outbreak gathered force. The epidemic was severe in January and February, but diminished in March and ceased at the end of April. During February 213 indigenous cases were reported, and such cases exceeded 100 in January and March, while the total number of cases reported was 624 and the deaths 515. The rate of attack per cent. of the census population was 1·5.

III.—(b.) (24.) *Course of the Plague in the Bombay Presidency in November* 1898.

Bombay Presidency, November 1898.

65. The mortality outside Bombay City, between the middle of October and the middle of November, was higher than it had ever been before. In the four weeks ending on

11th November 24,219 cases and 18,770 deaths were reported outside Bombay. The rural areas in the Satara, Belgaum, and Dharwar, districts, and in the Kolhapur country continued to be most severely affected. Over 16,500 deaths were reported from these tracts in the four weeks referred to above. The condition of the towns in this part of the country improved. Plague practically ceased in Hubli, and between the 28th October and the 25th November the cases reported in the towns of Dharwar and Belgaum fell to 474 and 142 respectively. From 29th October to 2nd December 408 cases occurred in the Poona district outside the City, and in this period of five weeks there were 292 cases in the Baroda State, and 237 in the State of Aundh. A few cases occurred at Karachi and Ahmednagar. There was a certain amount of plague in the Poona district, the Baroda State, Nasik, Bijapur, and Sholapur, but it was generally less than it had been. The infection was reduced to very slight dimensions in Surat, Broach, Kathiawar, the Cutch State, and the Thana district, the town of Thana becoming free of the disease which had existed in it since January 1898 and had caused 177 indigenous deaths in this outbreak.

An improvement took place after the middle of November. From the 5th to the 18th of that month the deaths from plague reported outside Bombay City were 8,740; in the next fortnight they were 6,787.

III.—(*b.*) (25.) *Course of the Plague in the Bombay Presidency in December* 1898.

Bombay Presidency, December 1898.

66. The improvement continued in December. The chief seat of the infection was still the rural tracts of Satara and the Southern Mahratta country, but the number of deaths reported there in the four weeks ending on 30th December fell to 7,629, of which 4,125 were reported from the Dharwar district. The situation in the other three tracts improved very materially, and in the Belgaum district the deaths reported did not exceed half the number reported in the previous month. The outbreaks in Belgaum and Dharwar towns practically ended during the month. Outside the Southern Mahratta country, the districts of Khandesh and Kanara became slightly infected. Plague got worse in the Kaira district, the Panch Mahals, and the Bijapur district (609 cases). It improved in the Poona district, Nasik, and the Baroda State. There was a little in the Ahmednagar district (only one case in the City) and the Sholapur district. In Kathiawar and the Cutch State the infection practically ceased, but 343 cases were reported from the Aundh State. In Karachi City only 16 cases were reported.

Second Outbreak at Baroda City, 1898–9.

In the City of Baroda there had been a few cases in November. These increased in December, and the epidemic was severe in January, February, and March, when the number of cases reported were 220, 300, and 379, respectively. It declined in April, and had ceased by the end of May. There were 1,096 indigenous cases and 886 deaths reported up to the end of May. The attacks in this outbreak were at the rate of 1 per cent. of the population.

III.—(*b.*) (26.) *Course of the Plague in the Bombay Presidency in January* 1899.

Bombay Presidency, January 1899.

67. There was still further improvement outside the City of Bombay in January 1899, and early in this month the capital of the Presidency became the most seriously infected place within it. In the five weeks ending 3rd February the cases reported outside Bombay itself numbered 10,227 and the deaths 8,152. The deaths reported from the Satara, Belgaum, and Dharwar, districts, and the Kolhapur territory, fell to about half what they had been in the previous period of four weeks. There was a little more plague in the Kaira district, the Panch Mahals (where there was a sharp outbreak at Godhra, population 14,700, which had become first infected towards the end of November), and the Thana district in which there was an outbreak of some virulence at Kalyan. The outbreaks at Broach, Baroda, and Aundh continued. In Karachi City there were 27 attacks. In Nasik and the Poona district the outlook became more promising. Plague continued in the Bijapur, Sholapur, Kanara, and Khandesh, districts, but not to any serious extent.

III.—(*b.*) (27.) *Course of the Plague in the Bombay Presidency in February* 1899.

Bombay Presidency, February 1899.

68. There was, on the whole, some improvement outside Bombay City during February, especially in the Southern Mahratta country. The cases reported outside Bombay between 4th February and 3rd March numbered 7,864, and the deaths 6,068. There were a number of deaths from plague in several towns in the Thana district,

notably Bassein and Bandra. Plague got worse in Baroda City the number of cases reported from the State being 563; and at Godhra (302 cases); but at the latter place the outbreak was declining rapidly before the end of the month. Two hundred and fifty-nine cases were reported from Broach, and 106 from Nasik town. Igatpuri, in the Nasik district, was slightly infected. Plague continued without being serious in the Poona, Ahmednagar, Kolaba, Sholapur, Khandesh, Bijapur, and Kaira, districts. More cases began to be reported in the Surat district. In Karachi City the number of deaths rose to 70, the prelude of another outbreak already referred to.

Third outbreak in Poona City, 1899.

Towards the close of the month Poona City, which had remained free for a long time, was again attacked. This outbreak at Poona has been extremely bad. In March the prospects looked very gloomy, but they improved in April and May. Plague grew a little worse in June and by 30th June 1,641 cases and 1,308 deaths had been reported since the week ending on the 27th January when the first case was reported.

III.—(*b.*) (28.) *Course of the Plague in the Bombay Presidency in March* 1899.

Bombay Presidency, March 1899.

69. The outbreak at Bombay City was at its height in March, and between 4th March and 31st March 6,882 cases, and 5,574 deaths, were reported from other places. From the Southern Mahratta country 1,372 deaths were reported, a number which, if large, is still much smaller than had been reported for some months. The most serious features of the visitation during this month were the outbreaks in some large cities. From Karachi City 767 cases were reported, from Poona City 393 cases, from the Baroda State 793 cases, from the Nasik district 281 of which 161 were indigenous cases in the town of Nasik, and from the Cutch State 326 cases, the town of Cutch Mandvi, with 300 indigenous cases, being chiefly affected. There were 119 cases in the town of Broach, but the outbreak was rapidly declining by the end of the month. A few cases were reported from the towns of Ahmednagar and Ratnagiri.

There was more plague than in the previous month in the Thana (953 cases) district, but at the end of the month cases ceased to occur in Kalyan after 195 indigenous deaths had been reported in the outbreak which had begun in that town in the beginning of December 1898.

Plague lingered, without being serious, in the Poona, Surat, Kolaba, Ahmednagar, Sholapur, Khandesh, Bijapur, Kaira, Kanara, and Rewa Kantha, districts. The outbreak at Godhra in the Panch Mahals ceased. In the last week of the month there were 1,639 cases outside Bombay City.

III.—(*b.*) (29.) *Course of the Plague in the Bombay Presidency in April* 1899.

Bombay Presidency, April 1899.

70. In April there was a substantial improvement, both in the City of Bombay and elsewhere. The number of cases reported outside Bombay from the 1st of April to the 5th of May was 6,903, and the deaths 5,309. In the weeks ending on 28th April and 5th May there were 895 and 828 deaths outside Bombay. The places which suffered most during the month were Karachi City (1,698 cases), Cutch Mandvi (1,071 cases), and Poona City (413 cases). Almost one half of the deaths reported outside Bombay City occurred in these three places. The Baroda State had 399 cases, and the Nasik district had 204; the outbreaks in Baroda City (131 cases) and Nasik town (145) began to decline materially before the close of the month, and that at Broach ceased. There were 94 cases at Ratnagiri town, but the outbreak was not serious. In the last week of the month 16 cases were reported from Belgaum town. Outside the places named there was more plague in the Thana district (776 cases) than elsewhere. Plague died out in the Panch Mahals. There were very few cases in the Poona and Surat districts, and but few in the Satara (258), Kolaba (304), Nasik, Dharwar, Belgaum, Khandesh, Bijapur, and Kaira, districts, and in the Kolhapur country.

Thirty-nine cases were reported from the town of Hyderabad in Sind, in which plague commenced again towards the end of March.

III.—(*b.*) (30.) *Course of the Plague in the Bombay Presidency in May* 1899.

Bombay Presidency, May 1899.

71. In the four weeks between 6th May and 26th May 2,297 cases and 1,797 deaths were reported outside Bombay City. Karachi City (369 cases), Cutch Mandvi (254), and Poona City (224), continued to be the places most infected. During the latter half of the month the epidemic at the two former places declined rapidly. Plague had not died out at Nasik (35 cases), or Baroda City (18 cases), but the mortality in both

these places was comparatively small. There were 40 cases at Ratnagiri, 40 cases in Belgaum City, and 25 cases at Hyderabad in Sind. The Khandesh district became free. The rural areas with most infection were in the Belgaum (193 cases), Satara (140), and Kolaba (130), districts, and the Kolhapur country (136).

Two hundred and twenty-four cases were reported from the Thana district where the outbreaks in Bandra and Bassein ceased about the end of the month. The outbreak in Bandra had commenced in the beginning of November 1898, and 333 indigenous deaths were reported in the town during its continuance. In Bassein the outbreak commenced in the beginning of December 1898, and caused 263 indigenous deaths.

In the week ending 26th May there were only 455 deaths outside Bombay City.

III.—(*b.*) (31.) *Course of the Plague in the Bombay Presidency in June* 1899.

Bombay Presidency, June 1899.

72. The returns from the week ending 2nd June to 30th June show 2,945 cases and 2,150 deaths outside Bombay City. In the last of the five weeks included in this period the figures are higher than in any of the previous weeks. The places most seriously affected during June were Poona City (482 cases), and Belgaum City (193 cases). At both these places the neighbouring Cantonment was also seriously affected, and the Belgaum district altogether had 714 cases. The outbreak at Nasik (107 cases) showed signs of reviving. The outbreaks at Baroda City and Cutch Mandvi had completely stopped, while at Karachi (72 cases) and Ratnagiri (33 cases) they had been reduced to very small dimensions. No more cases had occurred at Hyderabad in Sind. At the end of June there was no plague in the Baroda State, or the Sholapur and Kolaba districts, and practically none in the Ratnagiri, Ahmednagar, and Kaira, districts. Although it had not reached any serious proportions, it had at the close of the month begun to rise in the Poona and Satara (203 cases) districts and in the Kolhapur country (566 cases). In the Thana district 173 cases occurred; in the beginning of the month cases ceased in the town of Kurla, where they had been reported continuously since the beginning of December 1898, 203 indigenous deaths taking place in the town during this outbreak; by the end of the month 53 indigenous deaths had occurred in Bhiwandi, which was reinfected in the beginning of March, and the outbreak continued in the town after June; the town of Thana was reinfected during the month. There was a little plague in the Surat, Dharwar, and Bijapur, districts, and the aggregate number of deaths in these three districts in the week ending 30th June was only 71.

III.—(*c.*) *History of Plague, to the end of June* 1899, *in India outside the Bombay Presidency.*

Outbreaks in places other than the Bombay Presidency, Sind, and the adjoining Native States.

73. Of the outbreaks which have occurred outside the Bombay Presidency and Sind and the adjoining Native States, the most serious, though not the first in point of time, is that which began in the Mysore State during the rainy season of 1898. In Southern India there have been epidemics also in parts of the Hyderabad State in 1898 and 1899, and in certain districts of the Madras Presidency in the winter of 1898–99.

The Central Provinces, adjoining the north-eastern boundary of the Bombay Presidency, were not infected till nearly the end of 1898, and the infection was not then widespread, and did not last long. Of places more distant from Bombay, Calcutta, where cases had possibly occurred in 1896, became definitely infected in 1898, and had a second epidemic in 1899. During the latter epidemic the infection was carried to a number of other places in Bengal. The villages of two districts in the Punjab were infected in October 1897. Plague has been present there ever since. In the North-Western Provinces and Oudh, the only seat of infection has been Hardwar and a few small towns and villages in its immediate neighbourhood. Plague began there in April 1897 and ceased entirely in the beginning of 1898. A few villages were attacked in the Sirohi State in Rajputana in November 1897; the infection died out in April 1898, and has not reappeared. One village in the Gwalior State was infected in the beginning of 1897; the outbreak ceased in March, and there has been no recurrence of plague. This enumeration exhausts the list of outbreaks outside the Bombay Presidency and Sind and the Native States within or around them.

III.—(*c.*) (1.) *History of the Plague, to the end of June* 1899, *in Bangalore and the Mysore State.*

Outbreak in the Mysore State. 2534–6.

74 The Civil and Military Station of Bangalore and the City of Bangalore are practically one place, since the division between them is a purely artificial and

administrative one. The population of the Civil and Military Station is about 100,000 (of whom 13,000 are troops and followers), and that of the City about 80,000 to 85,000.

Introduction of the infection into Bangalore City and Civil and Military Station.
2538–44.

During the time that Hubli, which is closely connected by railway with Bangalore, was severely affected by plague the danger of the spread of the infection along the railway from Hubli to Bangalore was apprehended, and precautionary measures were adopted, both in the Civil and Military Station and in the City, to guard against the importation of the disease. In spite of these measures infection was imported from Hubli. In particular, on the 12th of August 1898, a case of plague was detected in the Civil and Military Station in a servant who had just returned to Bangalore from a visit to Hubli which had lasted four days. Owing to the promptness with which this case was detected, it would appear that it did not give origin to the subsequent outbreak in the Civil and Military Station. Two days later, on the 14th of August, 3230. it was ascertained that the City was infected and that the disease had probably existed there for some time before. The exact manner in which the infection was introduced has never been elicited, but the details regarding the discovery of the first cases are as follows. Inquiries instituted on the 12th of August in consequence of 3448. the occurrence of two burials from one house in the Gowdenpet quarter of the City—*i.e.*, the quarter which adjoins the railway goods yard—brought to light the facts that one of the persons buried had a bubo and that cases of fever had occurred in the house. Some of the inmates had already run away and died elsewhere. The discovery of other cases of plague in the neighbourhood followed, the employés of the railway goods sheds and workshops being the persons who were at first principally affected.

In view of the fact that the tranship coolies and the railway workshop hands were 3222-3. the first to suffer severely, it is suggested that the infection may have been introduced by the agency of rats, or in green hides or other goods, or possibly by infected railway waggons, from Hubli. No attempt was made to substantiate any of these suggestions except in the case of the raw hides. Some of these imported from Hubli are said to have been stolen by one Mustan, with the result that plague subsequently appeared in his house. Inquiries, however, elicited the fact that plague had already appeared in the house opposite Mustan's before any member of the latter's family was attacked. There is thus no reason to assume that the plague in Mustan's house was imputable to the stolen hides. Another focus of infection, which was by the local authorities assumed to have originated from a separate importation of the disease, was later discovered in the Akkipet quarter in the heart of the City. The infection is said to have been introduced here at the same time as, or a little later than, it was introduced into the Gowdenpet quarter, but the first case did not come to notice before the 22nd 3474. of August, when a railway guard was found to be suffering from plague. It was said that this man had already been ill eight days. It appears that the patient had not for a considerable period before his attack been to Hubli or to any other infected place, and it is therefore suggested that he was infected either by coolies who carried his baggage for him to and from the railway station, or by people from infected places who might have been smuggled through to his house, without undergoing the prescribed inspection on arrival at the railway station. There is no direct evidence in support of either of these suggestions. It is even, as Mr. Madhava Rao 3223. told us, uncertain "whether he was first attacked or his relatives or friends." The assumption that the guard contracted the disease from an importation of infection separate from that which gave rise to the plague in Gowdenpet, seems to us, therefore, to be a perfectly gratuitous one.

It was not till 15th September that cases of plague imported from the City were 2548. discovered in the Civil and Military Station. Indigenous cases in the Civil and Military Station began on 30th September.

City and Civil and Military Station of Bangalore: August 1898 to March 1899.

75. The number of cases reported in the City in the month of August was 22, and the deaths 15. In the next four weeks there were 205 cases and 129 deaths. At the beginning of October matters got much worse, and the returns for the four weeks ending 27th October showed 1,211 cases and 939 deaths. The outbreak at this time became bad in the Civil and Military Station, from which in these four weeks 224 cases and 150 deaths were reported. In the four weeks ending 24th November 1,361 cases and 1,129 deaths were reported from the City, and 1,261 cases with 1,036 deaths from the Civil and Military Station. During the second half of November the number of cases had begun to decline in the City. There was a further substantial improvement in the four weeks ending 23rd December. In that period there were 447 cases and 350 deaths in the City. The outbreak in the Civil and Military Station

was, however, getting worse at this time. The number of cases reported there was 2,077, and the deaths 1,720. After the middle of the month an improvement took place. In the following four weeks ending 20th January the number of cases reported in the City fell to 58, and the deaths to 71, while in the Civil and Military Station they were 358 and 311 respectively. The decline in the number of attacks at both places then became very rapid. Between 20th January and 3rd March 27 cases and 19 deaths were reported in the City, and 85 cases and 76 deaths in the Civil and Military Station. Between 3rd March and 31st March there were only four cases in the City, and then plague ceased there entirely. In the Civil and Military Station it lingered a little longer. Nineteen cases and 12 deaths were reported in March, and five cases, of which two were imported, and five deaths in April. There was one indigenous case in the last week of May, and one indigenous case in the last week of June, there being also two imported cases in May and two in June.

Comparison between outbreaks in the City and Civil and Military Station, Bangalore.

76. The two outbreaks thus ran practically the same course. Beginning in the Civil and Military Station a month after it had begun in the City, plague ceased in the latter place about a month later than in the former. The reported mortality from plague in Bangalore City from the beginning of the epidemic (12th August) up to 31st March was 2,655, and in the Civil and Military Station, from the end of September to the same date, 3,315. The total mortality during the same period was 7,237 in the City, and 6,272 in the Civil and Military Station. At the normal rate the deaths should have been in the City 867, and in the Civil and Military Station 1,041. The excess of mortality during the epidemic was thus 6,370 in the City, and 5,231 in the Civil and Military Station. Allowance has to be made, on the one hand, for the normal mortality having been pitched too low owing to defective registration in the past, and, on the other, for the fact that the mortality during the epidemic occurred among a population very reduced in numbers. It is estimated that at one time only 45,000 persons remained in the City, and 59,000 3504-5. in the Civil and Military Station. The real plague mortality was probably not less than 2639. the difference between the actual and the normal mortality. Assuming that this was the actual plague mortality, its incidence on the normal population would be 7·5 in the City, and 5·4 in the Civil and Military Station.

Measures adopted in the City and Civil and Military Station of Bangalore.

77. The measures adopted in the Civil and Military Station and in the City for dealing with the epidemic were, practically, the same. Both places were divided into circles, and the circles into blocks, and at first a voluntary agency was used to detect cases. In both places this agency broke down completely, and an official agency had 2536, 2553, to be substituted for it. House to house searching, with the help of soldiers, was 3273-6. adopted in the Civil and Military Station, but not in the City. The segregation of the 2572. sick and contacts was undertaken. At first the only exception to this rule was that, 3279. when a whole household had been inoculated, the patient and the family were allowed to remain on condition that the house was disinfected on the death or recovery of the patient. Segregation was much resented, and it was a complete failure in both 2684, 3348. the City and the Civil and Military Station. Many cases escaped detection, and those which were discovered were not, as a rule, found till after death, when the other inmates of the house had usually disappeared. In a certain number of cases dead bodies were found under circumstances which rendered it impossible to discover anything about them. Concealment of cases prevented the arrangements for disinfection from being at all complete. Bodies were removed from the houses in which death occurred, and many houses in which deaths took place were never known to have been infected. At first only houses in which cases were known to have occurred were disinfected, but at a later period of the epidemic the systematic disinfection of all houses in infected quarters was undertaken. The fear of the measures caused numbers of people, as has already been noticed, to desert both the City and the Civil and Military Station.

Mysore State, November 1898 to January 1899. Infection carried to parts of Mysore near Bangalore.

78. As the result of the exodus of the people from Bangalore, the neighbouring country became badly infected. The Mysore State is divided into eight districts. The infection spread into four of these districts, viz., the Bangalore, Mysore, Tumkur, and Kolar districts. Up to 7th December, excluding Mysore City, 51 villages had been found to be infected, and the number of cases and deaths returned from 3302. them had been 814 and 664 respectively. No difficulty was experienced in inducing the 3304-5. village population to vacate their houses on the occurrence of plague. In the week ending 17th December 532 cases and 446 deaths were returned from the villages, and in the following week 650 cases and 626 deaths, mainly in the Bangalore district.

in the first six weeks of the epidemic. Calculated on the difference between the actual and the normal mortality, the incidence of plague mortality was, up to the end of June, 3·5 per cent. on the population of the City of Mysore.

III.—(*c.*) (2.) *History of the Plague, to the end of June* 1899, *in the Hyderabad State.*

Outbreak in the Hyderabad State, December 1897. Progress of Plague to December 1898. 5153.

85. The first indigenous cases of plague in the territories of His Highness the Nizam were reported in December 1897. Up to the middle of December 1898, 67 villages had been attacked, the number of attacks reported up to that time having been 3,971, with 3,440 deaths. The outbreak commenced in the Naldurg district, on the roads leading from Sholapur to Bidar and Hyderabad. Plague had been raging in Sholapur City at the end of 1897, and many refugees from it crossed over into Hyderabad territory. The original infection from Sholapur at the end of 1897 was shortly followed by the introduction of the disease into another tract from the Ahmednagar district. It would appear that in the first three months of 1898 and up to the middle of April the infection was worst in the Naldurg and Ganjoti divisions of the Naldurg district, in the
5422. latter of which the town of Ganjoti had 243 cases and Umarghi had 194; the town of Palaskheda also returned 89 cases in this period, and parts of the Gulburga district were also among the places seriously affected. During April and May it was thought that the plague had died down in the Naldurg area, but the disease continued its hold in His Highness the Nizam's dominions. Later on the Lingsagur district, particularly the Kopbal subdivision, was infected from Dharwar and Bijapur, and in September numerous cases were reported in the Kopbal and Yelburga subdivisions of the district. In the former 539 cases occurred in Kowloor and 92 at Gudlanur up to the middle of December, and in the former, up to the same time, there were 428 cases at Bannikop and 219 at Sidnikop. In October the village of Sassora, in the Tuljapur subdivision of Naldurg, was infected and returned 135 cases up to the 12th December. In November the most serious spread of infection appears to have been in the Lingsagur district: up to the 12th December Sirguppi and Dotihal in the Kushtagi subdivision of the district had 145 and 109 cases respectively; Seyjulgooda and Nagarhal, in the Mudgal subdivision, had 82 and 65 cases up to that date; and in the Yelburga subdivision, Binhal, up to the 8th December, had 104 cases, and Erihanchinal had 71: by the end of the month the number of cases reported in these last two villages was 122 and 189 respectively.

Hyderabad State. Progress of plague, January to June 1899.

86. For the month of January 1899 and succeeding months we have received regular statements of plague in Hyderabad, from which we have prepared the following note of the progress of the disease in the State. In January 487 cases were reported from 43 places, of which 18 were newly infected. 175 cases occurred in the Naldurg district, and all the rest, except a few in Yelburga, in the Kopbal and other subdivisions of Lingsagur. Kopbal town, with the neighbouring towns of Katurgi and Kuknur, with a total population of 18,000, became infected during the month. The infection occurred among the Marwari traders of the place. The people resorted voluntarily to evacuation, which was commenced on the 25th January and completed by the last day of the month. In Kuknur only five cases were reported, and these all occurred in January, but in the two other towns the outbreak continued till April. In January, Kopbal had six cases, and Katurgi 47; in February, the numbers reported were 21 and 10 cases respectively; Kopbal had 22 cases in March, with five in April; while the reports show in Katurgi the occurrence of seven cases in March and one in April.

In February 628 cases occurred in 52 places in the State, of which 28 had not previously returned any cases. The outbreak at Mashal (143 cases all fatal) in the Gulburga district was the worst, but except for this the state of affairs in Gulburga improved, and Naldurg and Lingsagur (particularly the subdivisions of Kushtagi (169 cases), Gulburga, and Kopbal) remained the most affected districts.

In March the outbreak in Mashal continued severe (402 cases), and for this reason the Gulburga district showed the most infection. Though the total number of cases in the State rose to 675, there was a general improvement, except in Mashal, the largest number of cases which occurred in one place, next to Mashal, being 24 at Kinhal in Kopbal. Plague was reported from 46 places in all, and of these, 10 were newly infected during the month.

In April the cases reported for the whole State fell to 99. A village, Bho newly infected in the Naldurg district, had 15 cases, and two villages in the Kop subdivision each had 14 cases, but in all other places the number of reported ca was less. The Kopbal subdivision was worst infected, with five out of the 20 infected villages of the State; 8 villages in all were newly infected during the month.

In May, cases occurred in villages in the Lingsagur and Naldurg districts only. The largest number, 26, occurred in Tallihal, a place newly infected in Lingsagur. 33 cases were reported in all from the five villages in which alone cases occurred throughout the State during the month.

In June the Lingsagur district was free, except for 17 cases in two villages, of which 15 occurred in Tallihal. Two villages were also affected in Naldurg, of which one, Murli, returned 33 cases, having had none previously. The total number of cases for the month was 57, and the number reported from the beginning of January to the end of June amounted to 1,979.

Measures adopted in the Hyderabad State.
5155.
5455.
5465.
5466.

87. The measures adopted in the rural areas of the Hyderabad State were the evacuation of the infected villages, the disinfection of useless clothing and bedding by burning, and of bedding and clothing generally by boiling, and the disinfection of the infected houses by burning the surfaces of the floors and walls. Here, as elsewhere, the villagers after a time came to evacuate their villages at once on the occurrence of plague. Sepoys were posted in every village to prevent people from going from the infected to the uninfected area, and a census was maintained with the object of checking departures. The clothing and bedding of people leaving their houses was boiled twice, firstly, when they moved into camp, and, secondly, when they returned to their villages.

III.—(*c.*) (3.) *History of the Plague, to the end of June* 1899, *in the Madras Presidency.*

Outbreak in the Madras Presidency.
3832–93.
4104–19.
4397.

88. Plague occurred in August 1898 at Guntakal Junction in the Anantapur district of the Madras Presidency. It is not clear whether the local infection came from Bangalore or Hubli. The infected place, which is only a small railway centre, was cleared out and only six cases occurred. But a man took plague from Guntakal Junction to Timmencherla, a village of 2,000 people a mile off, and a woman afterwards took it from Timmencherla to Guntakal village (population 5,000). The policy followed in these villages was to make the people evacuate the village site and camp in the fields. The disinfection of the village was carried out often by detachments of native troops while the villagers were in camp. This system was followed in the agricultural areas which became infected in the Madras Presidency. The infection entered the Bellary district from Guntakal. Cases also began to occur in the town of Hosur in the Salem district, 25 miles by road from Bangalore, at the beginning of December, but indigenous plague did not occur there till about the end of January 1899.

Madras Presidency, December 1898 and January 1899.

89. In the first fortnight of December 1898, 128 seizures and 98 deaths were reported from the Anantapur, Bellary, and Salem, districts, most of the cases being indigenous. Indigenous cases were also reported from the Kurnool district in a village within 10 miles of infected villages in Guntakal and Bellary from which infection was probably imported. 149 cases in all were reported in the first fortnight of December, and 190 in the second fortnight, during which no fresh districts were indigenously affected. The number of cases in the Presidency in January 1899 was 230 in the first two weeks and 210 in the last two weeks, with 363 deaths in all. The North Arcot district for the first time had indigenous cases during the month. People with plague had come to the district from Bangalore as early as September, and eight imported cases occurred in December, but there was no local outbreak till plague appeared in an indigenous form in the town of Kuppam and the larger town of Vellore (population 45,000), following, in both cases, importation from Mysore.

Madras Presidency. Measures adopted in towns.

The infected quarter at Hospet (population 12,900) in the Bellary district, in which indigenous cases occurred, was evacuated, but plague did not stop, and it became necessary to eventually evacuate the whole of the town. The infection appeared at first in only one part of Kuppam, but when this quarter was recovering the other side of the town became suddenly infected, rats being first observed to suffer. Part of the town was evacuated at once, but, notwithstanding this, the outbreak spread. Contacts were segregated with difficulty. Only one ward of Vellore was infected at first. Nearly all the surrounding country is occupied by rocks, tanks, and wet cultivation. Evacuation on a large scale was in these circumstances impossible, and the people strongly objected to the transfer of contacts to the segregation camp. In most instances, in the early stage of the outbreak, home segregation was allowed. The result of this concession was, as appears from a statement made in the periodical reports relating to plague in the Madras Presidency, that the people were found more ready to help the authorities by giving information of sickness and accepting disinfection. Towards the end of January plague appeared in the town of Arcot (population 11,000). Cases occurred in all parts and the whole town seemed to be infected. Here also general evacuation was found to be impossible and home segregation was permitted. The people refused to go to the Government camp. People were not found so ready to help the authorities as they had been at Vellore. Cases began to occur in a different quarter in the latter town at the beginning of February. Wallajahnagar (population 10,500) immediately opposite Arcot, on the northern bank of the Palan, also became infected. The more severely infected part of the town was to a large extent evacuated. In this town home segregation was permitted. At the end of February Ranipettai, a town close to Wallajahnagar and Arcot, was infected. Here also the people were opposed to evacuation and refused to go to camps. So that in the four towns infected in the North Arcot district, viz., Arcot, Vellore, Wallajahnagar, and Ranipettai, the sick and contacts were segregated under guards in their own houses. While this was the course adopted in the above-mentioned towns, the general evacuation of the towns of Kuppam and Hosur was being carried out.

Madras Presidency, February to June 1890.

90. Eight hundred and one cases were reported from the 29th January to the 25th February. Cases were thus more numerous in February than in January, but an improvement took place in the latter half of the month in the agricultural tracts. The condition of the towns was still bad. From this time, however, the general outlook began to improve. In the fortnight ending on the 11th March there were 260 cases and 228 deaths, and in the next fortnight 169 cases and 123 deaths. 96 of the cases and 69 of the deaths in the latter fortnight were in the towns of Vellore, Kuppam, Arcot, Wallajahnagar, and Ranipettai, while 24 cases and 21 deaths occurred in Hosur. In April there was a further improvement. The number of cases reported in the four weeks ending 22nd April was 186, with 139 deaths. The decline continued in May. In the fortnight ending 6th May, Arcot, Hospet, and Kuppam, returned no cases of plague; there was only one each in Hosur and Wallajahnagar, eight in Vellore, and ten in Ranipettai. A change had come over the attitude of the people at Vellore, where the objection to segregation had diminished, and the majority of contacts were taken to the camp. By the beginning of June, plague had practically died out in all the towns except Ranipettai. In the two fortnights ending on the 3rd and 17th of June the number of cases reported in the Presidency was 30 and 15 respectively, while in the last fortnight of June only 10 cases and 5 deaths were reported from four places in the Salem district and from Ranipettai.

Total cases and deaths in Madras Presidency up to the end of June 1898.

91. The number of cases and deaths reported during the outbreaks up to the 1st July 1899 in the Madras Presidency, was 2,705 and 2,064 respectively. In the towns the number were as follows :—

District	Town.	Cases.	Deaths.
Bellary	Hospet	83	71
North Arcot	Arcot	173	132
	Kuppam	108	78
	Ranipettai	93	36
	Vellore	214	181
Salem	Hosur	115	88

The largest number of cases reported up to the date mentioned from other places was 136 from Guntakal, and 129 from Molagavalli.

The town of Madras has not been infected so far, though a number of imported cases have occurred in it.

III.—(*c.*) (4.) *History of the Plague, to the end of June* 1899, *in the Central Provinces.*

The Central Provinces, Outbreak at Hinganghat.

92. Plague did not become indigenous anywhere in the Central Provinces until the autumn of 1898, when it broke out in the town of Hinganghat, situated in the Wardha district. The population of the town is about 11,000, many of the inhabitants being mill hands, and there is a certain amount of communication between the place and Bombay.

Little information is available regarding the manner in which plague was imported into Hinganghat. In spite of the precautionary measures taken by the authorities to prevent its importation and to secure, in the event of their preventive measures failing, the early notification of the disease, the plague was imported and it

remained undetected till the 19th of November 1898, by which date it had probably 5977; 6200.
been in the place for some time, though the death rate was low and gave no indication
of its presence. It appears that the Hospital Assistant in charge of the local 6395-9.
dispensary had as early as the 11th of November treated a patient suffering from
fever and glandular swellings, and he said he had observed cases of the same nature
15 days before that date. Dead rats had been observed as early as the 7th of November.
It was subsequently discovered that in all 19 cases had occurred up to the 20th of
November, most of them among the mill hands and their relatives. Under these
circumstances it proved impossible to fix the first case or to determine the date of
the introduction of the disease. It was, however, suggested that two mill hands, who 6240-7; 6293.
arrived on the 4th of November from Bombay and who themselves remained healthy,
introduced the infection. This suggestion was not substantiated, and there were many
other arrivals from infected places.

The different quarters of the town were evacuated one after another, until the
whole town was practically evacuated by the 20th of December. A large
number of people were located in private camps. The outbreak had two separate 6001.
periods of virulence. Up to the 25th of November 38 seizures were registered,
six of them having been discovered on the 25th by a house search. Only one seizure
occurred between the 25th of November and the 2nd of December, and the disease
seemed to be dying out. The people were very anxious to go back to their
evacuated houses to get supplies and to look after their goods and their grain.
Disinfection had not been effectually completed, but under the circumstances the
authorities thought it safe to allow the people back into the town, and on the 28th of
November some of them were permitted to visit their houses. The visits were made 6007, 6024, 6069.
on the 29th November, and were promptly followed by a revival of the epidemic.
The fresh cases were discovered on 2nd December, by house searching. This discovery
led to the abandonment of the system of house inquiry on which reliance had at
first been placed, and thereafter house-searching was insisted on. The outbreak
subsided from the middle of January. Only two seizures and two deaths were
recorded in the week ending on the 3rd of February, and the same numbers from the
3rd to the 8th of February when the last case occurred. The town was declared free
of plague in March. In all there were 148 attacks and 124 deaths. The incidence
of attacks was 1·3, and that of deaths 1·1 per cent. of the population.

The Central Provinces. Outbreak at Wardha.

93. Hinganghat is distant 21 miles by rail from Wardha, the headquarters of the
district, a town of about 8,500 inhabitants. A case appears to have come into Wardha
from Hinganghat about the 23rd of November 1898, and to have escaped detection
till the patient was brought to the Plague Hospital on 28th November. The death
rate in Wardha, as in Hinganghat, had been for some time lower than usual. Two 6212-4.
indigenous cases were detected on 5th December in different parts of the town, and it
was soon discovered that plague was not confined to any particular part of it.
By the end of December the whole town was practically evacuated. Plague continued 6218.
in the town for about 14 weeks, the last case—that of a police-constable who
had recently come to Wardha from Nagpur—having occurred in the week ending
on the 3rd of March. The outbreak was never virulent, and there were only 76
reported cases, with 54 deaths. Of the 76 attacks, 38 were reported before 6th January.
The incidence of attacks was ·8 and that of deaths ·6 per cent. of the population.

The Central Provinces. Outbreak at Nagpur.

94. Nagpur, the headquarters of the Central Provinces, a town with a population,
excluding the Cantonment, of about 93,000, is 48 miles from Wardha, being, like it, on
the Great Indian Peninsula Railway. There was no plague in Nagpur before the end
of December 1898, and the actual mortality of the town during November and
December 1898 and January 1899, viz., 927, was considerably below the normal
(1,015). It seems likely, however, that the population within the town had decreased
owing to departures. Two imported cases of plague, both from Wardha, were
reported in the week ending on the 30th of December, 1898. The first that
occurred was that of a middle class Hindu who was in the habit of going to Wardha.
After returning from that place on the 21st of December, he was found on the
24th to be ill, and died in the hospital on the same day. The interval between the
death of the only arrivals at Nagpur who were known to have suffered from plague
and the first indigenous case was long. After 24th December there were no more
imported cases, and no indigenous case was found till 16th February. Five cases were
seen on the 17th, and enquiry then showed that from the 6th to the 16th February
there had been 12 deaths, which had in all probability resulted from plague. Six days

after the outbreak was discovered dead rats were found in its neighbourhood. For a time after plague had been discovered there were very few cases. Ten were found between 16th February and 23rd February, and then none till 11th March. On the 11th and 12th March there were two cases, one each day, and then no more till 20th March, and cases then continued to occur up to the 12th of May generally, but not always, in the vicinity of the part of the town which was first infected. The disease, however, never assumed the character of an epidemic, and in nearly all cases infection was traced to the locality originally infected in the town. The total number of detached cases was 36, of which 29 were fatal. With the exception of one person, who was treated in his own house, all the sick who did not appear to be moribund were taken to hospital, and the contacts to segregation camp. The neighbours were all sent to the observation camp for 10 days.

Plague in villages of the Central Provinces.

There was very little spread of infection to the villages in the neighbourhood from the outbreaks in the towns of the Central Provinces. Only two places (including Nagpur) outside the Wardha district were infected from Hinganghat or Wardha, and only four places were infected from Hinganghat, and eight from Wardha. In the villages, except at Takli, where there were 19 cases reported, all fatal, the disease was quickly controlled and suppressed.

III.—(*c.*) (5.) *History of the Plague, to the end of June* 1899, *in Bengal.*

The existence of plague in Calcutta suspected in 1896.

Vol. I., App. XXI. 26,817 *sqq.*

Para. 156 of this Report.

95. In the opinion of Dr. Simpson, formerly Medical Officer of Health for the Municipality of Calcutta, the existence of plague in Calcutta must be referred back to 1896, when a certain number of cases of bubonic disease were discovered in the city. The grounds upon which the diagnosis of plague was based were in some cases of the slenderest description, consisting as they did on the one hand in a clinical history of indolent bubo combined with a certain amount of transient constitutional disturbance, and on the other hand in the discovery, in the preparations made from the blood of patients, of a few isolated diplococcal forms, regarded as plague bacilli. In certain other cases, notably in the cases of Giga, Gulab, and Bepin, more serious grounds for suspicion existed. Two of these were cases of bubonic disease which ended fatally (one of them apparently in less than 24 hours), and the third, also a bubonic case, was associated with the occurrence of very suspicious illness among rats.

7101–16.

The source of infection could not be traced in any of these cases. In the case of Giga a suggestion was, indeed, thrown out that infection may have been imported in piece goods from Bombay, but the suspicion was quite unconfirmed.

Calcutta. Outbreak of plague in 1898; source of infection not traced. 6462; 6466; 6471–3.

We pass now to 1898, when there were undoubted cases of plague in Calcutta. The first case recognised as plague was that of a man who was found dead on the 17th of April 1898; he had not left the City for some time, and the source of his infection could not be traced. Anterior to the finding of this case it is probable that a certain number of cases had passed unrecognised. In particular it was afterwards found that one such case had been admitted into the Medical College Hospital as early as the 31st of March.

6608. 7178. 6701. 7481; 7488–97.

As to the source of the infection, Dr. Cook, the Medical Officer of Health for the City, said that there was no evidence of importation by land by a plague patient or by a person incubating the disease. Dr. Clemow went further, thinking that importation by rail was impossible. Major Evans held a similar opinion. But we may note that Major Dyson, though he was unable to obtain exact evidence regarding the case, had heard of a man who was said to have died of plague in Calcutta after arrival from Bombay, and Mr. Kailas Chandra Bose told us that he had known of people from infected places evading the railway measures and getting into Calcutta without the disinfection either of their persons or of their clothes.

7027; 7055. 7178.

Lieut.-Col. Sanders, I.M.S., thought that the plague had been introduced by a man who came by sea from Bombay in 1897 and landed ill with plague; the witness had seen this patient professionally two months after his arrival. Dr. Clemow, however, told us that no case of plague could be traced on any ship that had arrived at Calcutta.

7118–23.

Major Charles, I.M.S., and Dr. Cook seem to have been of opinion that the disease was introduced by rats conveyed in ships from plague-infected places to Calcutta. The former witness told us that he had heard of the death of rats on board ships which came to Calcutta, and he was of opinion that diseased rats escaped from ships and infected the rats in the neighbourhood of the wharves, and in particular in Fairlie Place, one of the first centres of plague in Calcutta. The facts of the case, so far as we have been able to gather them from Dr. Cook's Report on the plague in

Calcutta, are that dead rats were found about the 15th of April, in the East Indian Railways Printing House in Fairlie Place and in the Steam Navigation Company's godowns in which goods were stored. We have, however, seen that the disease had been in Calcutta for some time before these dead rats were found. I. 464.

In view of the careful system of railway inspection which was in force and of the difficulties placed in the way of the importation of infection by sea-passengers, owing to the fact that the voyage from Bombay rarely lasts less than three weeks, Major Evans was of opinion that the infection could not have been brought by people, but must have been introduced in infected articles. 6882.

From the above summary of opinions, it will be seen that there is no accurate information available as to how the plague was introduced into Calcutta.

Measures adopted at Calcutta in April 1898, and exodus of population. 6540–1. 6520–39.

96. The announcement that plague was in Calcutta was followed by a large exodus of the population. It is estimated that 150,000 to 200,000 of the population of 700,000 left, mainly owing to panic due to fears regarding the measures which might be taken. Unscrupulous persons did their best to foment panic and to deter people from being inoculated. The sick were, except in a few instances, taken to hospital. After the first case or two, none of the contacts were placed in segregation camp. They were required to vacate the room in which a case occurred, but were allowed to go where they liked. The infected room was thoroughly disinfected. Houses adjoining infected houses were not evacuated.

Calcutta. Statistics, April of September, 1898. P. 473 Vol. I. 6757. 6575, 6815.

97. Plague was never severe in Calcutta during this outbreak. Up to 31st July, 1898, there were 190 cases and 155 deaths, and up to the end of September 230 cases and 192 deaths. The average number of cases was 39 in a month, and the highest number (77) occurred in June. These cases occurred in a period of about five months, and the incidence of plague cases was only ·03 per cent. of the census population. Of the 230 cases found, 188 were males and 42 females, or four males to every female. Cases were generally found after death, or just before it, and the disproportion of male and female attacks points to some concealment of cases. It could not, however, have been large, since the mortality from all causes between April and September 1898 was low, even if allowance be made for the number of persons who had left the town.

Second outbreak at Calcutta, February 1899. 6756. 6760–93. App. No. B. in Vol. II.

98. Calcutta was declared free from plague on 10th October, 1898. But there were shortly afterwards a few cases, and it would appear that plague was never absolutely extinct, though it was reduced to an extremely small amount. In February 1899 the town was again declared to be infected. We have been favoured by the Government of Bengal with an account of this outbreak up to 27th May, in the letter from the Secretary to that Government, dated 14th June, 1899. On this occasion it was determined to leave the sick, if they preferred it, to be treated in their own houses. Prompt disinfection of infected premises was mainly relied on to prevent the spread of the disease. The treatment of plague patients in their rooms to some extent interfered with the complete disinfection of the premises, but, on the other hand, the absence of compulsory segregation encouraged the people to report plague, so that many places were disinfected which would otherwise have escaped. Very few cases came to light in which there was a recurrence of the disease after disinfection, and "from the time when" in consequence of prompt reports of plague, "disinfection became immediate the epidemic began to abate." It is impossible to assert that the abatement was the result of the proceedings for disinfection. Vol. II., p. 534, para. 8.

Calcutta. Mortality, February to June 1899. Para. 5 of Bengal Government letter of 14th June 1899, App. B., Vol. II.

99. There appear to have been 59 attacks and 44 deaths from plague from 8th January, 1899, up to the week ending 4th March: of these deaths 33 took place after 24th February. In the four weeks ending on 1st April 492 cases were reported, and 439 deaths. The figures for the four weeks ending 29th April were 502 cases and 459 deaths. In the middle of April the outbreak began to decline. In the four weeks ending 27th May there were 189 cases and 175 deaths. There were 81 deaths in the fortnight ending 31st May and 49 in the remaining four weeks before 1st July.

Since the difference between the actual and the average mortality from the beginning of March to the end of May is considerably less than the number of reported deaths from plague, it would appear probable that there was not any general concealment of plague during this period. The ratio of mortality from plague to the population of the town from the commencement of the second outbreak until the end of June is only ·17 per cent.

Outbreaks in Bengal, outside Calcutta.
7331-75.
Para. 10, Bengal Government letter above quoted.

100. The infection did not spread from Calcutta much into the interior of Bengal. In the earlier period of the epidemic an outbreak took place in the Backergunge district, but it was quickly suppressed. In the spring and summer of 1899 the plague had spread into 15 districts of the province; but in eight of them the total number of cases was only 21. In the remaining seven there were up to the middle of June 509 cases and 413 deaths. By that time plague had disappeared from every place outside Calcutta, except the town of Howrah which is only separated from Calcutta by the river.

III.—(*c.*) (6.) *History of the Plague, to the end of June* 1899, *in the Punjab.*

Outbreak in the Punjab.
Procs. of H.H. the Lieut.-Gov. of the Punjab, Home (Med. and San.) Dep., No. 1479. L.P., dated 17.12.98.

101. A considerable amount of plague has occurred in the Jullundur and Hoshiarpur districts in the Punjab. The outbreak practically was confined to two revenue sub-divisions of the Jullundur district and one of the Hoshiarpur district. Up to the end of September 1898, 86 villages, with an aggregate population of 91,892, were attacked. The number of seizures reported was 3,409 (3·7 per cent. of the population) with 2,103 deaths. During this period only two towns, viz., Banga (population 5,010) and Garhshankar (population 6,000) were attacked.

Punjab.
Source of infection of Khatkar Kalan not certain.
Spread of plague, October to December 1897.
9917-30.

102. Plague was detected within this area in a small village called Khatkar Kalan in the Jullundur district on 21st October 1897. The suggestion has been made that the infection of this village was due to one Ram Saran, who returned to it from Hardwar at the end of April 1897. It is not certain that Ram Saran, who died the day after his return to Khatkar Kalan, actually died of plague, though it appears probable that he did so. In the interval between his death and the discovery of plague in the village (a period of nearly six months) there were a few suspicious deaths among people connected with him. There is, however, nothing in the nature of proof to connect the outbreak in Khatkar Kalan in October 1897 with the visit of Ram Saran to Hardwar in April of that year. No facts were available to suggest any other means by which the infection reached the Punjab. Many residents of the Punjab are employed on steam vessels which sail from Bombay, and others go there in search of other employment. Though there is nothing to show that this was the case, it seems possible that the infection may have been taken to the Punjab by some one who had been to Bombay for employment.

9933.
App. XXXIV.

On the discovery of plague in Khatkar Kalan, special arrangements were made to search the neighbouring villages. During November plague was discovered in two more villages in the Jullundur district, and in one in the Hoshiarpur district. In December one fresh village was found to be infected in the Jullundur district.

Measures adopted in the Punjab.
9977.
10,235.
9980.
10,459.
9984.
9993.
10,048.
10,057.
9996.
10,013-42.
10,054.
10,049.

103. Energetic measures were taken to prevent the spread of plague. When plague was discovered in a village it was evacuated. Partial evacuation was tried in some larger villages, and especially in Banga town, but it failed in most cases, and total evacuation had to be resorted to. The largest places evacuated in the Jullundur district were Rahon, with a population of 10,000, and Banga, and in the Hoshiarpur district Garhshankar. Considerable opposition in some places was experienced towards the measures adopted, and this culminated in an attack on the police at Garhshankar in April 1898. The police were obliged to fire on the mob, and the town was forcibly evacuated, after which no more resistance was experienced, either in the Hoshiarpur or the Jullundur district. The people were allowed to take as much property as they could with them, but their houses were not stripped till later on when disinfection took place. The people and their effects were disinfected on entry into the camp and were required to put out their property in the sun every day for 10 days after arrival in camp. In camp the sick and contacts were kept apart from the rest. While in camp the people were placed between two cordons, one round the village site to prevent people from entering it from the camps, and the other outside the land in the immediate vicinity of the village to prevent communication between the infected village and the outside world. After the people had been in camp for 10 days the houses were disinfected. There were four processes in the work of disinfection, viz., firstly, disinfecting with antiseptic solutions; secondly, cleansing; thirdly, ventilating; and fourthly, whitewashing. The people were kept in camp until they had been free from disease for three weeks, and were permitted to return only after they had taken a phenyle bath and all their property had been dipped in phenyle.

Punjab.
Course of

104. Up to the end of the year 1897, only five villages had been found to be infected. No fresh centres were found in January 1898, though it would appear that

seven had been attacked. The two villages originally infected were declared free in this month. In the month of February 15 and in March 27 fresh villages were discovered to be infected. The outbreak was very severe in April, when 33 fresh villages were found to be infected. The number of attacks fell rapidly in the end of May. Plague was detected in only eight new villages in that month and in one in June. A few cases occurred in June and July; at the beginning of June one fresh village was infected, and towards the end of July one case which occurred was found in a village which had before been infected and declared free, while four cases of a mild type were 10,541, 10,551.
discovered in a village which had previously had only one case, and that not followed by reports of other cases. In August some cases were discovered in two villages which had been previously infected, and in a third which had not. At the end of September cases were discovered in two other villages. In the middle of November it was discovered that the town of Rahon (population, 10,667) was infected. There had 10,459, 10,553.
evidently been at least one death from plague previously, which had been reported as due to asthma. The cases first discovered were in separate quarters of 10,534.
the town. It is uncertain how Rahon became infected. Plague had been present 10,546.
in the village of Kariam since September, and the last case reported there was on 2nd November, a few days before the first case was reported at Rahon. An 10,555.
easy explanation is that the infection came from Kariam, but against it is the fact that the people attacked in Rahon were of a different race to those attacked in Kariam. It appears possible that infected clothes may have been passed from Kariam to Rahon in bags of fodder, which are known to have been secretly passed across the cordon. Two quarters of the town were evacuated and the other usual measures were 10,562.
adopted. The residents were, in due course, allowed to return, and plague then started in another quarter, a resident of which had been in the habit of visiting the man whose disciple he was while in segregation camp. The whole town was then placed in camp. The evacuation began on 25th December, and was completed by 12th January. Only 12 cases and six deaths occurred in all; the date of the last case was 22nd February 1899.

the plague January 1898 to June 1899. App. XXXIV.

Procs. of H.H. the Lieut. Gov. quoted above.

The infection in 1899 spread to 27 villages, of which nine had been infected in 1898. It was discovered in two villages in February 1899, in two in March, in 15 in April, in six in May, and in two in June. The outbreak was not severe. By the middle of June 361 cases and 202 deaths had been reported outside the town of Rahon, and by the end of June the outbreak ceased. Seven cases of plague, with 2 deaths, occurred in a small village of the Gujar Khan subdivision of the Rawalpindi district, from the 20th to the 23rd June. There were no further cases, and the source of infection was not traced.

III.—(c.) (7.) *History of the Plague in 1897–8 in the North-Western Provinces.*

Outbreak in the North Western Provinces. Hardwar.

105. Plague was discovered in Hardwar, a town of 5,000 inhabitants, in the extreme north of the North Western Provinces, in the first week in April 1897. Hardwar is situated where the Ganges flows into the plains. Kankhal is one mile from Hardwar, on the same side of the river, and Jawalapur is about three miles off on the opposite side 9003, 9016, 9212.
of the Ganges Canal, the head of which is half a mile below Hardwar. At the time when plague was introduced into Hardwar, the disease was epidemic only in localities that are situated at a great distance from that town. The existence of plague in the 9025.
town was first ascertained on the 8th of April 1897. On that date information reached the authorities of the death of a woman who had been living in a lodging house frequented by Sindis from Karachi. A suspicion—subsequently confirmed by bacteriological examination—that the woman had died of plague, led to the inspection of the lodging house in which she had lived, and on the 8th of April the woman who kept the house was found to be recovering from an attack of plague, having been ill for about a month. Mr. Winter, the m of the district in which Hardwar is

river: and (*b*) by the circumstance that some of the first cases of plague which came to light in Hardwar occurred near the Post Office. When it is noted that no case of plague occurred among the postal officials, it will be obvious that the theory rests on 9029-48. App. XXVIII. a very slender basis of fact. The outbreak at Hardwar was confined to a large block of about five or six acres, which it was easy to cut off from the rest of the town. This block was evacuated, and the whole town disinfected. The number of persons 9064. actually left in the town was between 300 and 500. There were 18 cases of plague at Hardwar, the last on 8th June 1898.

North Western Provinces. Kankhal. 9066-9.

106. The town of Kankhal is of about the same size as Hardwar. A man from Hardwar died in Kankhal from plague on 16th May, 1897, and in the first week of June rats began to die in Kankhal. It was not, however, till the beginning of August that suspicious deaths began to occur in the town, and plague was not 9073. recognised there till 16th September. 9101-2. The infected block was then evacuated, but other parts of the town began to be infected. Block after block was evacuated on ten or eleven different occasions, till the inhabitants of the town were all in camp by the end of October. The houses were disinfected by the middle of November. After evacuation a few cases occurred in the camp, and the epidemic came to 9113. an end in December. There were 61 cases of plague during the outbreak at Kankhal, 9132. 51 before the end of October, 5 in November, 4 in December, and 1 at the beginning of January 1898. The incidence of attacks on the population was 1·2 per cent. A 9119-23. special incident of this outbreak was the considerable mortality among the monkeys which infest Kankhal, and some of them undoubtedly died of plague.

North Western Provinces. Jamalpur, Jagjitpur, and neighbouring villages. 9133-4. 9137-48.

107. An outbreak of plague occurred in two villages in the neighbourhood of Kankhal, and sporadic cases in six other villages. In the villages where sporadic cases occurred a large area round the infected house was evacuated, and the actually infected house was, as a rule, burnt. The two villages in which an outbreak took place were Jagjitpur and Jamalpur. The former, Jagjitpur, is a village of 1,200 inhabitants, in which plague was detected on 29th December 1897. The infection seems to have come from Kankhal. The people were evacuated by 8th January 1898. Ten cases occurred before evacuation, and 13 afterwards; all the latter, with one or two exceptions, within a few days of the evacuation of the 9150-68. village. Jamalpur (population 1,400) was attacked on 12th February 1898. The father of the first person attacked had been to Jawalapur a few days before. The second case occurred a week after. A portion of the village was evacuated immediately. Then two disinfection coolies were attacked, and then four more cases occurred in the village at the beginning of March. The village was evacuated by 10th March. Twenty-six more cases occurred, the last on 18th April. The disease, especially during the later stage of the outbreak, was observed to run through families, and not to spread to those not related to persons previously affected.

North Western Provinces. Jawalapur. 9173-86.

108. The most severe outbreak in the neighbourhood took place at Jawalapur, a town of about 16,000 inhabitants. About 13,000 persons were present in the town when plague began and the number fell to 12,000 in February. The first case was discovered on 9th January, 1898, but it was impossible to trace the source of infection. A block was evacuated at once and disinfection started. An attempt was made to disinfect the whole town without evacuation, but this was found not to be sufficient, and cases occurred very rapidly. On the occurrence of each case a fresh area was evacuated and eventually there was a voluntary evacuation of the whole town except a quarter occupied by 600 persons. Plague was practically stopped at the end of April, and the people returned during the last three weeks of that month. There were three cases in May, one being the case of a man engaged in work connected with disinfection, the second that of a person who was attacked and died in the town after returning to her house, and the third that of a relation of the second, who died in the segregation camp. Of the 116 cases 31 occurred in the t the segregation or contact camps, 30 in

expensive. In addition to the civil and medical establishments employed there was at 9212.
one period of the outbreak a force of police and village watchmen numbering nearly 9230
450 employed on them.

III.—(*c.*) (8.) *History of the Epidemic of Plague in the Sirohi State in* 1897–8.'

110. Plague was taken to Teuri in the Sirohi State by a shopkeeper from Poona, Outbreak in the
who died the day after his arrival in the village. At the funeral feast his clothes were Sirohi State,
distributed. The infection was not discovered till 22nd November 1897. Seventeen November 1897. 9702.
deaths had then taken place in four villages within two miles of one another. The 9709–91.
people were at once taken out of the villages into camps and kept there for some time.
Nine cases occurred after their removal. The houses were disinfected. The people 9770.
who were not infected were on account of the cold weather allowed to return to their
homes early. All the 26 persons attacked in this outbreak belonged to the Banniah 9764.
(shopkeeper) caste.

111. At the beginning of January fresh cases of plague were discovered in three of Sirohi State.
the villages that had been infected in November, and in Kalindri, a village of 4,000 Second outbreak in
inhabitants, which had escaped at that time. The people were again moved out of January 1898. 9810.
their villages, and those from two villages were in camp on 11th January, those from 9823.
the third on 21st January, and those from Kalindri on 20th January. A force of 9879.
police and soldiers (20 in number when the villages were being evacuated, and 140
directly afterwards) was employed to prevent the people from going to their own or
neighbouring villages. Plague ceased four days after evacuation in the village
evacuated on 21st January (population 400). There were five cases before the people 9825–9.
evacuated the village, and three afterwards. In Teuri (population 1,800) there were 9873–7.
six cases before the people went into camp, and 20 afterwards. Plague continued
for 20 days after evacuation. In Sheudial (population 1200) there were nine cases 9862–6.
before the people went into camp, and 13 afterwards. The last case was 22 days
after evacuation. The outbreak was more obstinate in Kalindri. Eighteen cases 9830–8.
occurred before the place was evacuated, 20 between 20th January and the end of the
month, 32 in February, and eight in March. Three weeks after other cases had ceased 9859–61.
there were six isolated cases in April among people who were about half a mile away
from the village in a place in or near which there had before been no plague.

Of the 140 persons attacked in this outbreak, 117 died. The houses were more 9886.
thoroughly disinfected than on the first occasion, and were kept unroofed for a
considerable time. There has been no return of plague to this district.

III.—(*c.*) (9.) *History of the Epidemic of Plague at Khandraoni in the Gwalior State in* 1897–8.

112. The village of Khandraoni is situated in the State of His Highness the Outbreak in the
Maharaja of Gwalior, and has a population of about 450. It was infected early in Gwalior State. 9643.
January 1897 by two brothers, natives of the village, who had been living in 9637.
Bombay. One of them apparently travelled, when sick, from Bombay, and died a few
days after his arrival in the village. His brother, who travelled with him, fell ill two
days after his death, and died three days later. Others were attacked in about a week,
and then the outbreak took place. It did not come to the notice of the authorities
till the middle of March, when 59 persons had been attacked, of whom 47 had died.
At this stage of the outbreak the village was evacuated, the sick and contacts
segregated, and the village cut off from neighbouring villages by a cordon of soldiers. 9694.
The soldiers were also employed to cut the crops. Four hundred and fifty men were 9650–3.
engaged on these duties. Only four cases occurred after the village was evacuated, 9662.
the last in the hospital camp on the 12th day after evacuation. The village was
disinfected, and a part of it burnt down. The infection did not spread to any
neighbouring place.

IV.—HISTORY OF THE PLAGUE IN INDIA IN JULY, AUGUST, AND SEPTEMBER, 1899.

IV.—(1.) *Course of the Plague in Bombay City in July, August, and September,* 1899.

113. The above account carries the history of the present outbreak of plague in Bombay City.
India down to the end of June 1899. We may supplement it with a short account of July, August, and
what occurred between the end of June and the end of September 1899. September 1899.

During July, August and September, plague was not severe in Bombay City. The decline in the number of cases which had set in in March continued till July, but, as in 1898, the number of cases began to increase again after July. The increase, however, in 1899, was less than it had been in the previous year. From the 1st to the 28th July 1899, only 280 cases were reported to have occurred; 484 cases were reported in the five weeks ending on the 1st of September 1899, and in the next four weeks, ending on the 29th September 1899, the number reported was 403. The figures for the corresponding periods in 1898 were 296 cases in four weeks in July, 709 cases in the next five weeks (August), and 844 cases in four weeks in September. The number of plague deaths reported to have occurred from the 1st July to the 29th September 1899 was 980; during this period the actual mortality from all causes (8,179 deaths) exceeded the average number of deaths from all causes for the period (6,994) by 1,185.

IV.—(2.) *Course of the Plague in the Bombay Presidency in July, August, and September*, 1899.

Bombay Presidency, excluding Bombay City. July, August, and September 1899.

114. Excluding the City of Bombay, there occurred in the Bombay Presidency, from the 2nd to the 30th June 1899, 2,582 plague cases with 1,754 deaths. The numbers rose in the period from the 1st to the 28th July to 9,033 cases and 6,782 deaths—more than three-and-a-half times as many as in the previous four weeks. In August, again, there was a very great rise in the figures; 23,397 cases and 17,947 deaths took place from the 28th July to the 1st September. In September there was a further rise, but it was not so large, the numbers of cases and deaths that occurred from the 2nd to the 29th September being 23,776 and 17,951 respectively.

Poona, Nasik, Ahmednagar, and the Southern Mahratta country and neighbouring districts. July, August, and September 1899.

115. In the Bombay Presidency, the most serious outbreak of plague during July August and September 1899 was that in the City and district of Poona. In the City, the number of cases was large in July, attained its maximum in August, and began to decline in September; during the three months the total numbers of indigenous cases in the City, in the Cantonments, and within the suburban limits of the Municipality, were 10,158, 1,686, and 244 respectively. In the Poona district, where there was little plague in June, the disease spread very widely during the months now in question. The Cantonment of Kirki was again attacked in the middle of July and had 150 indigenous cases up to the end of September. During these three months the districts also of Belgaum, Nasik, Satara, Dharwar, and Ahmednagar, and the Kolhapur State, were badly infected. The number of cases that occurred in July was much greater than the number that had occurred in June, and the increase of cases in August and September was very considerable. Taking together all the places and districts named above, 2,264 cases occurred in them in June, and the number rose to 8,035 in July, and to 20,801 in September. The state of affairs in these districts and places is shown in the following table:—

1899.	26th May to 30th June.		1st July to 28th July.		29th July to 1st Sept.		2nd Sept. to 29th Sept.	
	Cases.	Villages infected at end of Period.	Cases.	Villages infected at end of Period.	Cases.	Villages infected at end of Period.	Cases.	Villages infected at end of Period.
Poona City - - -	482	—	2,519	—	6,884	—	2,820	—
„ district - -	25	5	189	11	1,293	30	3,106	70
Belgaum district - -	714	18	1,930	44	3,511	66	3,105	76
Kolhapur State - -	566	14	1,576	26	3,033	40	3,028	61
Nasik district - -	129	2	714	12	2,708	29	3,545	54
Satara district - -	203	7	774	18	1,433	37	2,315	53
Dharwar district - -	131	9	282	13	845	19	1,573	26
Ahmednagar district -	14	1	51	4	489	9	1,309	13
Totals - -	2,264		8,035		20,196		20,801	

In the Belgaum district the most important places which were attacked were the City and Cantonments of Belgaum, and the town of Nipani (population 11,800). Plague continued in these places during the whole of July, August, and September, and the number of indigenous cases that occurred was 1,641 in the City, 304 in the Cantonments, and 474 in Nipani. The principal places attacked in the Nasik district were Nasik town, Sinnar, and Igatpuri, which had 1,684, 623, and 272 indigenous cases respectively; the two former towns had plague throughout the three months, and Igatpuri was re-infected in the first week of July. Satara town was not again infected, and the largest places which had plague in the Satara district were Karad, re-infected in the third week of July (586 indigenous cases), and Tasgaon, where cases had continued to occur since the middle of February 1899, the number of deaths reported between the time of re-infection and the end of September being 332, of which 128 occurred in the three months now under consideration. Dharwar town was infected during the whole period now under consideration, while Hubli and Gadag, in the Dharwar district, became re-infected in the second week of July. Up to the 29th of September there had been 745 indigenous cases in Dharwar town, 720 in Hubli, and 37 in Gadag. Ahmednagar town became infected towards the end of July, and by the end of September had had 1,006 indigenous cases.

In the neighbourhood of the districts named above there was plague in the Bijapur and Sholapur districts, and in the States of Akalkot, Savanur, Bhor, and Aundh. In Bijapur the number of cases increased from 49 and 90 in June and July to 507 and 549 in August and September, the number of places infected in the district at the end of September being 21. Sholapur, which was practically free in the first two months, had 140 and 179 cases in the last two months, and by the end of September 10 places in the district were attacked. Plague re-appeared in Akalkot in September, when there were 20 cases. In Savanur the number of cases rose from three in July to 118 in September. The outbreak in Aundh also became more severe during the period under consideration, there being 41 cases in July and 192 in September. The Bhor State was re-infected in August, when it had 35 cases; there were 97 cases in the State during September.

Places near and to the south of Bombay.
July, August, and September, 1899.

116. Places in the neighbourhood, and to the south, of Bombay continued infected. The outbreaks, however, declined in the Kanara district, and were slight in the Janjira State, the Kolaba district, and the Ratnagiri district, the most seriously infected of these being the district of Ratnagiri, which had 91 cases in September. In the Thana district the infection was worse, and 277, 535, and 244 cases respectively occurred there in July, August, and September. The towns of Thana and Bhiwandi had plague throughout these months, the number of indigenous cases that occurred in them being 115 and 660. Two other considerable towns in the district, Bassein and Kurla, were re-infected. The re-appearance of plague in Bassein occurred in the third week of July, and 52 indigenous cases took place before the end of September. Kurla was not re-infected till late in August and had only a few cases.

The Central and Northern part of Bombay Presidency, excluding Sind.
July, August, and September 1899.

117. In the Central and Northern part of the Bombay Presidency, excluding Sind, there was plague during July, August, and September, 1899 in Khandesh, Surat, and Broach, Rewa Kantha, the State of Baroda, the Kaira and Ahmedabad districts and the Cutch State, and Kutiana in Kathiawar. There was practically no plague in these places in June, except in Surat and the Cutch State, and the number of cases reported in July, August, and September was not large. Khandesh, Ahmedabad, and Kathiawar had no cases in July, a very few cases in August (when plague reappeared in these places), and a few cases in September. In the other places named the outbreaks generally were more severe in August than in July, with a slight decrease of cases in September. The largest number of attacks was that reported from the Surat district, which had 153 cases in July, 387 in August, and 346 in September, the number of places infected in the district at the end of September being 8. The towns of Surat and Bulsar remained infected throughout the three months, and in that period had 414 and 129 indigenous cases respectively. Kaira had 56, 288, and 181 cases respectively in July, August and September, and at the end of the period there were 10 places infected in the district. The number of cases that occurred in the other places named exceeded 100 in August in Broach, in the Cutch and Baroda States, and in Rewa Kantha, and in September in the Cutch and Baroda States only. The town of Cutch Mandvi was free from plague except for a few days, and Baroda City, though it was re-infected in the beginning of August, had only 11 indigenous cases between the date of its re-infection and the end of September. In Rewa Kantha the town of Balasinor was infected in the beginning of June, and had 198 indigenous cases in the period now under consideration.

Sind.
July, August, and September 1899.

118. In Sind, the plague in the City and district of Karachi, where there had been 72 and 17 cases respectively in June 1899, declined in July. In that month 13 cases only were reported in Sind. All these occurred in Karachi City, in which cases

continued to occur during the next two months, there being 11 in the five weeks ending on the 1st September, and 22 in the four weeks ending on the 29th September. The Karachi district remained free in August, but in September it had six cases, which were not indigenous. The town of Hyderabad was re-infected in the middle of August, and had 151 cases between the date of re-infection and the 1st September, with 258 cases in the next four weeks.

IV.—(3.) *Course of the Plague in Bangalore and the Mysore State in July, August, and September*, 1899.

Mysore State. July, August, and September 1899.

119. Outside the Bombay Presidency there was plague in July, August, and September, 1899, in Mysore, the Hyderabad State, the Madras Presidency, the Central Provinces, Bengal, and the Punjab.

Plague had ceased in Bangalore City in the end of March 1899, but after the middle of June the infection was again imported into the City. The infection was imported from an infected part of the Mysore State, and in the week ending on the 23rd June there were four indigenous cases, followed by five more indigenous cases in the last week of June. From the 1st to the 28th July 20 cases, all indigenous, occurred in the City. In the next four weeks the number of cases rose to 28, of which all but one were indigenous. In the next five weeks, ending on the 29th September 1899, there was a further rise, to 47 cases—of which only two were imported.

In each of the months of May and June 1899, only three cases of plague had occurred in the Civil and Military Station of Bangalore, two of the cases in each month being imported, and one being indigenous. Two cases, both indigenous, occurred in July, in the last two weeks of the month. In August such cases began to occur more frequently. In the week ending on the 25th August there were four such cases, in the next week there were eight, and indigenous plague cases then continued to be reported every week. From the 1st to the 29th September there were 25 cases in the Civil and Military Station (all but seven being indigenous), and in the last week of this period the indigenous cases amounted to nine.

The number of cases reported from Mysore City was 61 in July 1899—a slight increase on the number reported in the previous month. In August the number of cases fell to 46, and in the four weeks ending on the 29th September there was a still further fall to 25 cases.

The state of affairs in the districts of the Mysore State during the three months now in question is shown in the following table :—

Period.	Bangalore.		Mysore.		Kolar.		Tumkur.		Chitaldrug.	
	Villages infected at end of Period.	Cases during Period.	Villages infected at end of Period.	Cases during Period.	Villages infected at end of Period.	Cases during Period.	Villages infected at end of Period.	Cases during Period.	Villages infected at end of Period.	Cases during Period.
1–28 July 1899 - - -	13	242	12	160	4	70	1	4	—	—
29 July—1 September 1899 -	25	276	16	336	5	145	5	82	1	1
2–29 September 1899 - -	23	272	13	205	7	106	1	16	3	145

Throughout the whole of the period for which figures are given above, the state of affairs in the Bangalore and Mysore districts was worse than it had been in June 1899; the returns for September however, showed signs of improvement. In Kolar, including the gold fields, plague declined, and in Tumkur and Chitaldrug the number of places attacked was small. The other districts of the State had no plague.

IV.—(4.) *Course of the Plague in the Hyderabad State in July, August, and September*, 1899.

Hyderabad State. July, August, and September 1899.

120. In H.H. the Nizam's dominions there was a large increase of plague in July 1899. In the previous month only four villages remained infected, and 57 cases had

occurred. In July there were 813 cases in 25 villages. The Naldurg district with 362 cases in 10 villages, and the Gulburga district with 308 cases in 6 villages, were worst infected, 123 cases being reported in the Lingsagur district and 19 cases in Bidar.

In August plague was reported from 38 villages in the State, and the number of cases rose to 985. 247 cases occurred in Gangawathi, a village in the Kushtagi sub-division of Lingsagur, and eight other villages in that district had 82 cases. 482 cases occurred in the Naldurg district, in which the worst affected tract was that of Ganjoti, containing, among other infected places, the town of Umerga, which reported 79 cases in August, and 86 in the previous month.

In September the total number of infected villages rose to 48, and the number of plague cases to 1,334. The Naldurg district continued to be the worst infected. In it 844 cases were reported from 24 villages; the number of cases in Umerga fell to 13, but Muram had 249 cases, and Alur 119. The Lingsagur and Gulburga districts had 8 and 11 infected places with 273 and 180 cases respectively, the places with most plague being Gangawathi (139 cases) and Lingsagur (63 cases) in the Lingsagur district, and Jawargi (110 cases) in Gulburga.

IV.—(5.) *Course of the Plague in the Madras Presidency in July, August, and September*, 1899.

Madras Presidency.
July, August, and September 1899.

121. In the Madras Presidency, outside the Salem district where the outbreak was not severe, there was practically no plague during July, August, and September 1899. Anantapur had four cases in two places in July and August; North Arcot reported one case in July and another in the fortnight covering the end of September and the beginning of October, and Bellary also had one case in the period last mentioned. In Salem, from the 1st to the 29th July, six places reported 34 cases; in the next four weeks 11 places reported 22 cases; and in the six weeks ending on the 8th October there were 13 places infected, in which 88 cases were reported.

IV.—(6.) *Course of the Plague in the Central Provinces in July, August, and September*, 1899.

Central Provinces.
August and September 1899.

122. In August 1899 plague re-appeared in the town of Nagpur, in the Central Provinces. Up to the 30th August 22 cases occurred, while between the 30th August and the 1st October the number of cases in the town rose to 154. The outbreak continued after the end of September. A village near the town was infected in the beginning of September by a contact who had got out of Nagpur, but prompt measures suppressed the outbreak in the village, after two fatal cases had occurred. At the end of September two other villages became infected.

IV.—(7.) *Course of the Plague in Bengal in July, August, and September*, 1899.

Bengal.
July, August, and September, 1899.

123. In Bengal plague occurred during July, August, and September, 1899, only in Calcutta and Howrah. The number of cases and deaths reported in Calcutta gradually increased from 10 cases, all fatal, in the first fortnight of July to 113 cases, with 110 deaths, in the last fortnight of August. In the first and second fortnights of September respectively there were reported 103 cases, all fatal, and 100 cases, of which 99 were fatal. The total for the three months was 460 cases and 454 deaths. It is to be noticed that on the average of the mortality returns for past years, on the assumption that there was no exodus at this time, 2,406 deaths from all causes might have been expected to occur from the 16th August to the 30th September, and that in 1899 in this period the number of deaths that actually did occur was 2,684. In Howrah there were during July, August, and September 1899, 16 cases of plague with 15 deaths; nine of these cases with eight deaths occurred in the first fortnight of August, and there was only one case and death in September. In the last fortnight of September a few cases suspected to be plague occurred in the Saran district.

IV.—(8.) *Course of the Plague in the Punjab in July, August, and September*, 1899.

Punjab.
July 1899.

124. In the Punjab there were five cases on the 16th July 1899, in a village of the Murree revenue subdivision of the Rawalpindi district. These cases all ended in recovery, and they were not followed by other cases. A few cases occurred in a village which had been infected in June in the Hoshiarpur district, but the disease practically disappeared from the Province by the end of July 1899.

V.—GENERAL REMARKS ON THE MORTALITY DUE TO PLAGUE IN INDIA.

General remarks on the mortality from plague.

125. It will be observed from the details given above regarding the outbreaks at the larger centres at which plague has occurred, that the differences in the proportion of the population which has been attacked and has died at different places have been very striking. In some places the percentage of attacks and deaths has been very high. Up to the 29th September 1899, counting indigenous cases only, and stating populations according to the returns of the Census of 1891, there had been in the different outbreaks which have attacked Poona City and Cantonments and Kirki 23,262 reported cases with 18,063 deaths out of a population of 172,341; in Karachi City, 10,498 cases with 8,156 deaths out of a population of 105,199; in the town of Bulsar, 1,625 cases with 1,191 deaths out of a population of 12,999; at Bhiwandi, 3,004 cases with 2,197 deaths out of a population of 14,387; at Karad, 2,171 cases with 1,714 deaths out of a population of 12,374; in Belgaum City and Cantonment, 6,826 cases with 5,298 deaths out of a population of 41,413; at Sangli in the Sangli State in Kolhapur, 3,010 cases with 2,682 deaths out of a population of 14,798; at Shahapur in the same State, 2,202 cases with 1,924 deaths out of a population of 12,046; at Cutch Mandvi, 6,999 cases with 5,832 deaths out of a population of 38,155; at Bantwa, 944 cases with 602 deaths out of a population of 8,200.

In some small places the mortality was still more appalling. It is estimated that in the Portuguese Settlement of Lower Daman 2,000 out of a population of 7,000 died
I. 306. between the end of February and the beginning of June 1897. In the Dharwar
1601. district some villages suffered fearfully during the autumn of 1898. At Ibrahimpur (population 1,716) the attacks came to 50, and the deaths to 35, per cent. of the population; at Ingalhalli (population 2,203) the corresponding figures were 48 and 37;
23,518. at Datnal (population 1,280), 45 and 36; at Shelwadi (population 4,222), 32 and 28;
2192. at Lingdhal (population 1,469), 30 and 25; and at Bayahatti (population 3,589), 28 and 22. We have quoted these instances to show how severe an outbreak of plague may be. Although this enumeration does not exhaust the list of very severe outbreaks, cases in which the mortality has even approached these figures have been very rare. The number of outbreaks in which even 10 per cent. of the population has been attacked is comparatively small.

Total recorded plague mortality in India from September 1896 to September 1899.

126. The deaths reported up to the 29th September 1899 as due to plague in the Bombay Presidency, including the Native States connected with that Presidency, number 250,677. The plague deaths reported up to the end of September 1899 from other Provinces of British India and from Native States outside Bombay number about 36,300. There is, however, no doubt that the reported deaths do not represent the real mortality from plague, and in order to obtain an adequate estimate of the mortality due to the present epidemic of the disease in India, we may, without undue exaggeration, assume that even as many as 35 per cent. of deaths really due to plague have been wrongly assigned to other causes. On this assumption the mortality from plague in the 36 months from September 1896 to September 1899 amounts to over 376,000 in the Bombay Presidency, and to about 54,450 in the rest of India. This computation gives a total of about 430,500 deaths for the whole of India.

If we restrict ourselves to the figures for the Bombay Presidency and the connected Native States, within which plague has been principally confined up to the end of 1899, we find that, in a population which in 1891 amounted to about 19,400,000, the computed number of deaths from plague in three years represents 1·9 per cent. of the population, and, if the mortality were spread equally over the three years, this would give an annual death rate of ·6 per cent. The effect of plague, however, on the mortality of the whole of India has been much less than this. The population of the whole of India may, without taking account of any increase that may have occurred since the census of 1891, be taken as being over 287 millions, and a calculation on this of the computed number of deaths up to September 1899 shows that only ·15 per cent. of that population has during three years died of plague, giving a death rate that is equal to an average mortality of ·05 per cent. per annum.

Total plague mortality recorded in India not high in comparison with total mortality from "fevers" and cholera in India.

127. A comparison of the above figures with the vital statistics compiled for India during recent years shows that the mortality from plague has not as yet attained to any considerable proportion of the total mortality of the country, and that plague has not in three years been able to extend and take a hold of the country in such a way as seriously to affect the ordinary death rate. In British India the average annual number of deaths from all causes during the six years from 1893 to 1898 has been about 6½ millions, in a population which may be reckoned at 221 millions on the

census of 1891 and without making allowances for any increase that may have occurred since the census. The figure, 6½ millions, may be taken as fairly representing the average mortality of an ordinary year. The diseases which contribute most to this total are "fevers" and cholera. The incidence of mortality from "fevers" and cholera varies considerably in different parts of India; the mortality from cholera varies considerably from year to year; the mortality from "fevers," which is very inaccurately classified but in the main represents deaths which are the direct or indirect results of malaria, is fairly constant from year to year over the whole of British India. Calculated on the returns for the years from 1893 to 1898, the average number of deaths from cholera in British India was about 370,000 per annum, or about ·16 of the population, the cholera mortality in the Bombay Presidency, excluding the connected Native States, being about ·14 per cent. of the population; while the deaths from "fevers" amounted annually in British India to more than 4⅓ millions, or about 2 per cent. of the population. Taking with these figures the figures which we have given above for plague, we find that, in the three years following the appearance of the present epidemic of plague in Bombay, although the mortality from plague in the Bombay Presidency has been far larger than the average mortality from cholera in the same area, the plague mortality has not, over the whole of India, approached the average mortality from cholera, while over the whole of India the plague mortality of three years amounts to only a little more than 9·5 per cent. of the mortality attributed in British India to "fevers" in a single year, and has equalled about 6·6 only of the total mortality in British India in an ordinary year. Thus, although the figures of plague mortality when taken by themselves are high, it is evident that plague has not as yet been able to make itself felt as one of the most important factors that influence the total mortality of India.

CHAPTER III.

CHARACTER OF PLAGUE, AND THE MEANS BY WHICH THE DISEASE IS COMMUNICATED AND SPREAD FROM PLACE TO PLACE.

I.—Scope of Chapter.

Scope of the Chapter.

128. We have embodied in the historical survey which forms the subject-matter of the last Chapter, the results of our special inquiries into the origin of plague epidemics in some of the more important centres of population which have been visited by the disease in India. It will have been seen in the course of that survey that in none of the centres in question was definite information available as to the manner in which the plague was introduced. In this Chapter we proceed to describe the character of plague and to study in detail the means by which the disease is communicated and spread from place to place. With a view to throwing light upon these questions, we propose on the one hand to draw upon the clinical and bacteriological facts which have been obtained from a scientific study of the disease and its specific infective agent, the plague bacillus, and on the other hand to draw upon the epidemiological observations which have been furnished to us by Medical Officers and others engaged in plague operations in India.

Order in which the subject-matters are discussed in this Chapter.

129. It will be well to preface our consideration of the wide ranging subject-matter which will come under review by setting forth in brief synopsis the plan adopted in this Chapter.

Main features of plague.

We commence by setting forth so much of the main features of the disease as is essential to the proper appreciation of the facts which come under consideration in connexion with the spread of plague.

Bacteriology.

This done, we consider the plague bacillus, dealing first with its morphological and cultural characteristics, the conditions which favour its growth, and its powers of resistance outside the organism. Following upon this, we discuss the means which are available for differentiating the specific infective agent of plague from other bacteria, by microscopical examination, cultivation on artificial media, and inoculation into animals.

Mode of infection.

We then pass to the discussion of the mode in which the infective agent may effect an entrance into the organism.

Incubation period.

The duration of the incubation period is next discussed.

Clinical features.

The detailed description of the clinical symptoms and pathological anatomy of plague and the consideration of the statistical data available with regard to case mortality and the relative frequency of various clinical forms of the disease, and also certain facts with regard to the recurrence of the disease in the same person, would, at this point, quite naturally have come up for discussion. But, inasmuch as these questions have only an indirect relation to the particular subject-matter in hand and lie somewhat outside the scope of our Reference, we have decided that they can best be dealt with in Appendices. In Appendix I., for which we are jointly responsible, will be found the purely statistical matter which we have collected, and in Appendix II. the clinical features of plague have been dealt with by the President.

Infectivity of persons, rats, houses, and other objects.

We therefore pass on directly from the discussion of the incubation period to the discussion of the infectivity of plague. Beginning the consideration of this question by treating of the infectivity of plague patients generally, we then consider, under a series of separate headings, the infectivity of the various clinical forms of plague. After disposing of the question of the infectivity of the human patient, we consider the question of the infectivity of rats infected with, or dead of, the disease. The infectivity of dwelling-houses, of clothes and household effects, and of merchandise, which may have come in contact with plague patients or plague rats, next comes under consideration.

Manner in which the disease spreads.

The discussion of the questions dealt with above will then naturally lead up to the consideration of the manner in which plague spreads from infected to uninfected towns and villages, and then from house to house within an infected town or village; incidentally, and with a view to making our discussion of the question of spread complete, we deal also with the conveyance of plague over sea.

Influence of age, &c.

Another aspect of the matter then presents itself, this being the question as to how far age, sex, race, occupation, and habits, affect the liability of the individual to plague infection.

Epidemiological problems.

Lastly, we endeavour to complete our survey of the question of the spread of plague by considering a series of epidemiological problems which arise in connexion with the disease. Such problems present themselves (*a*) in connexion with the question of the occurrence of a prolonged interval between the importation of infection and the epidemic outbreak of the disease; (*b*) in connexion with the occurrence of atypical forms of the disease at the outset of an epidemic; (*c*) in connexion with the fatality of plague at different phases of an epidemic; (*d*) in connexion with the influence of meteorological conditions and seasonal variations in the severity of plague epidemics; (*e*) in connexion with the influence of insanitary surroundings on the severity of plague epidemics; (*f*) in connexion with the existence of an endemic focus of plague in the Himalayas, and the general question of the possibility of a recrudescence of the disease, apart from re-importation of the infection; and (*g*) in connexion with the theory that the plague bacillus requires to be acclimatised to the particular conditions obtaining in each locality before it can give origin to a plague epidemic.

II.—GENERAL SURVEY OF THE CHARACTER OF PLAGUE.

Brief review of former appearances of plague in India and elsewhere.

130. In conformity with our scheme, we begin with a general survey of the character of the disease.

Ever since the dawn of history we have records of epidemics of pestilential disease, associated with buboes and accompanied by a very high mortality. The pestilential disease characterised by "emerods in the secret parts," which is noted in the biblical records as striking down small and great among the Philistines in the time of the Judges; the pestilence which devastated Athens during the course of the Peloponesian War; the "Black Death" of the Middle Ages; the "Great Plague" of London; the fatal pestilential disease which was widespread in the Deccan and Western India, during the latter part of the 17th Century; and the plague at Marseilles in the 18th Century; were probably all true bubonic plague. Coming to more recent times there is no doubt that, on the one hand, the "Oriental Plague" of Turkey, Egypt, and the Levant, in the early part of the 19th Century, and, on the other hand, the plague which occurred in Western India at various times from 1812 to 1837, were genuine bubonic plague; and, lastly, it seems, as we shall see, to be beyond question that the "Mahamari" which, from 1823 onwards, has been reported from the Himalayas, is to be identified with genuine plague.

Difficulties experienced in former epidemics in connexion with the identification of atypical forms of plague in man.

131. The difficulty of discriminating plague from other diseases in pre-bacteriological days is well brought out by the fact that, both in the case of the plague in Western India in the early part of the present century, and in the case of the mahamari of the Himalayas, some observers were of opinion that the epidemics with which they were dealing were epidemics, not of true bubonic plague, but of typhus, a disease which, both in its epidemiology, and in certain of its clinical characters, has many points of similarity with plague. Again, the difficulties, in the absence of bacteriological investigation, of diagnosing certain forms of plague, are well illustrated by the uncertainty which has constantly prevailed as to whether cases of pneumonic affections and cases of high fever ending fatally, where such came under observation in association with cases of typical bubonic plague, were to be regarded as aberrant forms of the disease. We may refer here, for instance, to the fact that in the case of the plague, which raged in Kathiawar and the adjoining parts of Western India in the second decade of the 19th Century, there came under observation epidemics, which must, from their clinical description, have been epidemics of pneumonic plague, and which were, even then, surmised to be such.*

Early surmises with regard to the occurrence of plague in animals.

132. The uncertainty that prevailed in pre-bacteriological days, as to what forms of disease should be brought under the category of plague, extended also to diseases occurring among animals concurrently with epidemics of plague among men. Murrain among cattle, and mortality among rats, are frequently recorded as having occurred in association with plague epidemics, though it is remarkable that mortality among rats has not figured so prominently in the descriptions of past epidemics as might in accordance with recent experience have been expected. Perhaps the earliest passage which has been unearthed with reference to mortality among rats, is a passage from the *Bhagavati Purana*, quoted by Mr. Hankin in a memorandum on plague, enjoining upon the people that they should abandon their houses when rats "fall from the roof above, jump about, and die." Noteworthy also in this connexion is a passage cited from the biblical writings, where it is recorded that the Philistines, with a view to staying the plague which was devastating them, made golden images of their emerods and of "the mice that marred the land," and placed them with the Ark when they sent this back into the land of Judah. In the case of India, the occurrence of mortality among rats in the Himalayan villages, in association with the outbreak of plague among men, has been recorded from 1830 onwards. The Pali plague also was, it would seem, accompanied by rat mortality.

Classification of the different types of plague in man in the light of recent clinical study and bacteriological investigation.

133. Since 1894, when the plague bacillus was discovered, it has been possible to confirm, or as the case might be to correct, the inferences arrived at in pre-bacteriological days with regard to the human and animal diseases which were previously surmised to stand in association with plague. It has now been placed beyond doubt, by accurate clinical study and bacteriological investigation, that the plague may in man assume any one of several very different clinical forms. It will conduce to the intelligibility of what will be said in the sequel with regard to the spread of plague if we here very briefly characterise these different manifestations of plague.

(1.) Bubonic type.

(1.) Plague, in its most typical variety, takes the form of bubonic plague. In this form of plague the bacteria are carried by the lymph stream into the lymphatic glands, in particular into the lymphatic glands of the groin and the axilla—less frequently into those of the neck. The bacteria multiply there, and excite a considerable amount of swelling and inflammation, which manifest themselves in the form of a bubo. The development of this bubo is often associated with severe pain. Following closely upon—more rarely preceding—the development of the bubo, constitutional symptoms set in. They consist in malaise, headache, and fever, frequently accompanied by collapse and vomiting. When the bacteria have grown through the meshes of the lymphatic filter, they are carried on by the lymph stream into the blood. The disease then becomes septicæmic.

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* *See* Report on a disease which prevailed in Kattyawar in 1819-20, by Thomas Whyte, Esq., Bombay Medical and Physical Society, Vol. I., 1838, p. 167; *and* Report on a disease which prevailed in the Zillah of Ahmedabad, in the years 1817-9, by J. Gilder, Bombay Medical and Physical Society, Vol. I., 1838, p. 190.

(2.) Septicæmic type.

(2.) Distinguishable clinically, though, from the point of view of the pathologist, not sharply marked off from the secondary plague septicæmias just described, are the cases of plague commonly spoken of as septicæmic in contradistinction to bubonic cases. These are the cases where, owing to the more rapid passage of bacteria through the lymphatic filter, and possibly to a greater production of bacterial poisons, the constitutional symptoms precede and overshadow the local symptoms, the disease being in most cases rapidly fatal.

(3.) Pneumonic type.

(3.) In a third form of plague, first bacteriologically established by Captain Childe, I.M.S., plague bacilli invade the lungs and give rise to pneumonia, death occurring in most cases within a few days after the patient has been attacked. Owing to the absence of buboes, the pneumonic form is often classed, along with the septicæmic form, in the category of non-bubonic plague.

(4.) Pestis minor or ambulans.

(4.) In addition to the three main types of plague which have been described above, an abortive form of bubonic plague comes under observation. This is technically known as pestis minor, or pestis ambulans. It cannot be doubted that in these abortive bubonic cases the bacteria are, as in the case of ordinary bubonic plague, carried to the lymphatic glands, but they are held back there, the disease stopping short of the septicæmic stage. In correspondence with this the constitutional symptoms are very light. Indeed in certain cases, not only the constitutional, but also the local, symptoms may be so slight as to be, except for their pathological interest, almost undeserving of attention. Such cases appear to be extremely common among persons who have been much exposed to the infection of plague, and are characterised by sensations of numbness and tingling, or by neuralgic pains, which in many cases are associated with the development of shotty glands in the armpits and the groins. We may, however, remark here that the whole question of pestis minor urgently requires to be more fully elucidated.

Susceptibility to plague infection of various classes of animals, and the spontaneous occurrence of epidemics among them.

134. Passing from the consideration of the various forms in which plague may manifest itself in man to the question of the occurrence of the disease in animals, it is to be noted that this question also has been considerably elucidated by recent bacteriological research. It has been established beyond doubt by inoculation experiments that rats, mice, guinea pigs, and squirrels, can readily be infected with plague. Among the most susceptible animals may be enumerated also certain species of monkeys. Rabbits are less readily infected by plague, while cats are even less readily infected. Inoculation experiments, and the negative experience which has accumulated from countless places in India, would appear to show definitely that cattle, and the larger animals generally, are insusceptible to the disease. Birds appear to be almost incapable of contracting the infection.

Para. 270 of this Report.

Finally, we may note that it has been established, in many cases by bacteriological examinations, which are more particularly referred to hereafter, that epidemics which have occurred among animals in association with plague among men have been epidemics of plague. Such epidemics have been shown to occur in India, not only among rats, but also among mice, among squirrels, and among monkeys. In the particular case of rats, the symptoms associated with the outbreak of plague among them are very striking. The rats come out of their holes in the broad daylight, the hair of their coat stands on end, they stagger about in a dazed condition, so much so that they can be easily killed, and when the disease terminates fatally they are seen to fall over on their side, death being preceded by general paralysis, or more commonly by a series of violent tetanic spasms. In isolated cases cats also appear, so far as can be judged from the clinical symptoms, to have been found suffering from the disease.

These preliminary points having been dealt with, we may pass on to the consideration of the infective agent of plague.

III.—Bacteriology of Plague.

III.(*a*).—*Morphology of the Plague Bacillus.*

Shape and dimensions of the plague bacillus.

135. The bacillus of plague (or cocco-bacillus, as it ought in accordance with stricter nomenclature to be called) is, as seen in its typical form, a small ovoid micro-organism,

varying between 1 and 2 micro-millimetres in length and between 0·4 and 0·8 micro millimetres in breadth.

Staining reactions, and disposition of the plague bacillus as seen in material derived from the infected organism.

136. The plague bacillus can readily be stained by basic aniline dyes. It does not retain the stain when treated by Gram's process, unless when weakened (50 per cent.) spirit is employed in lieu of absolute alcohol in the decolourization process. As seen in the blood and infected tissues, the micro-organisms are for the most part found either disposed singly or aggregated together in twos, forming the so-called 'diplo-coccal forms.' Occasionally, however, and in particular in the peritoneal effusion of guinea pigs and rats, the bacteria may be aggregated together into 'strepto-coccal forms.' These strepto-coccal forms may also under exceptional circumstances be found in the buboes of plague-infected animals. Plague bacteria of most irregular shapes, resembling the involution forms presently to be described in connexion with artificial cultures, are occasionally to be met with in the infected organism, more particularly in the tissues of animals which have acquired, or which possess by nature, a certain amount of resistance to plague. Degenerated plague bacilli are found also in blood taken some time after death from men or animals that have succumbed to plague; under such circumstances the bacilli are found to have lost their sharp outlines, and to have swollen up into spherical forms which, to a large extent, have lost their property of staining with basic aniline dyes. At a later stage the micro-organisms are found to have become distinctly vacuolated, this last change being probably a preliminary to a dissolution of the bacilli in the body fluids.

Details of morphology of the bacillus as seen in stained preparations.

137. In preparations stained with any of the ordinary basic dyes, and in particular in preparations which have been treated first with a dilute solution of acetic acid and afterwards with a solution of methylene blue or carbol fuchsin, the ends of the bacillus are found to have taken the dye while the central portion generally remains unstained. The unstained portion or vacuole, instead of being centrally situated, may, in some cases, be situated either laterally or at one extremity of the bacillus. Though almost invariably to be seen in the case of plague bacilli obtained directly from the animal organism (being particularly well seen in the case of bacilli derived from buboes at a late stage of their development), the central vacuole is only exceptionally to be seen in bacilli taken directly from artificial media after having been cultivated thereon for a series of successive generations.

The bacillus furnished with a capsule in the form of a glutinous envelope.

138. In preparations which have been treated with ordinary basic dyes, the bacillus is occasionally seen surrounded by a clear unstained halo. In silver stained specimens, and, indeed, in specimens stained by many of the other methods used for demonstrating flagella, a definite, finely granular, faintly stained, envelope can without difficulty be seen round the bacillus. The appearances just described are probably to be interpreted as signifying that the bacillus is surrounded by a gelatinous covering. Whether we dignify this by the designation of a capsule or not, it at any rate appears certain that the individual bacilli in the organs and tissues of the infected organism—and the same thing holds true, as we shall see, of bacilli grown on artificial nutrient media—are embedded in and bound together by a kind of glutinous matrix.

Question as to whether the plague bacillus is motile and provided with flagella.

139. The plague bacillus does not appear to possess any power of spontaneous motility. We have not been able to detect anything of the movement which Gordon, on the one hand, and Kasenski, on the other, claim to have occasionally seen in individual bacilli derived from young cultures. Neither have we been able, either by Van Ermengen's method, or by any other method of staining, to detect the presence of flagella, described by Gordon as occurring in cultures which have been cultivated for 24 hours on agar at the temperature of 30° C. (86° F.).

Question as to the development of spores.

140. No trustworthy observer has yet detected anything in the nature of a spore formation in the plague bacillus, either within or without the organism. Moreover, old plague cultures are not more resistant to heat and antiseptics than young plague cultures. It may, therefore, we think, be assumed with confidence that the plague bacillus does not form spores. It is true that it has been asserted that a production of spores takes place in broth cultures of plague to which small quantities of phenol have been added. But the observations in question seem to us quite unconvincing. We think it probable that the the spore-like involution forms, which may, as we shall see, develop in such media, may have been confused with genuine spores.

III.(*b*).—*Conditions affecting the Development of the Plague Bacillus outside the Organism, and Specific Character of Plague in Artificial Cultures.*

Conditions affecting development of plague bacillus in artificial cultures.

141. Before passing on to describe the appearances of plague bacilli when growing on artificial media, it may be well to summarise a few general points with regard to the conditions which are respectively favourable and unfavourable to the growth and survival of the plague bacillus in artificial cultures.

Nature and reaction of nutrient medium.

The plague bacillus grows well on ordinary agar, gelatine, and bouillon. It grows less well in glycerinized media. Luxuriant growth is obtained only on neutral or slightly alkaline media.

Temperature.

Unlike most pathogenic micro-organisms, the plague bacillus appears to grow best at temperatures below blood heat. The optimum temperature is probably to be found between 30° and 36° C. (circa 86° to 97° F.). Cultures of the plague bacillus, however, develop satisfactorily at temperatures of 20° to 25° C. (68° to 77° F.). According to the Austrian Plague Commission, who have carefully investigated this point, satisfactory growth is obtained even at temperatures as high as 42° C. (circa 107° F.). At the lower end of the scale, a certain amount of growth occurs even at temperatures as low as those which ordinarily obtain in an ice-safe. In the case of two series of experiments conducted by the Austrian Plague Commission, distinct, though slow, growth was observed in cultures kept in the ice-safe at average temperatures of 11°·8 C. (53° F.) and 6·9° C. (44°·5 F.) respectively. The same phenomenon has been observed by one of us.

Report of Austrian Plague Commission, Part II. C., pp. 625–627.

Aeration.

In artificial cultures the plague bacillus grows luxuriantly only when it is provided in abundance with oxygen. A certain amount of growth does, however, take place where the supply of oxygen is as limited as it is in the depth of gelatine or agar tubes. And even when oxygen has, by a stream of hydrogen gas, been all but completely removed from a culture medium, the growth of the plague bacillus would appear not to be entirely suspended.

Destructive and injurious influences which may come into operation on the plague bacillus outside the human organism.

Section III.(4) in Chapter VI. of this Report.

142. The discussion of the destructive and injurious influences which may come into operation on the plague bacillus outside the human organism may conveniently be treated of under two headings. Under one of these headings would fall the discussion of the destructive influences exerted by chemical disinfectants, extreme heat, desiccation, and direct sunlight. We shall deal with these in a subsequent chapter where the general question of disinfection will come up for consideration. Under another heading would come naturally a discussion of the influence exerted on the plague bacillus; (*a*) by exclusive cultivation on artificial media and cultivation under special conditions; (*b*) by exposure of the cultures to extremes of cold; and (*c*) by the passage of the bacillus through a series of animals. The discussion of the influences grouped under this latter heading may appropriately be taken up here. It will be found that they have an important bearing on some of the problems in connexion with the spread of plague which we shall presently have to consider.

Length of survival on artificial media.

Report of Austrian Plague Commission, Part II. C., p. 630.

143. Unlike many other pathogenic micro-organisms, the plague bacillus retains its vitality, and, apparently, in many cases also its virulence, for considerable periods when grown on artificial media. The Austrian Plague Commission, who devoted special attention to this matter, give it as their experience that the plague bacillus generally remains alive on agar for several months. In exceptional cases it may remain alive much longer, and in one particular instance, detailed by the above mentioned observers, the bacillus was found alive on agar 470 days after the tube had been originally inoculated. All the observations in question apply to cases where the cultures were to some extent protected from desiccation by being kept at a temperature not exceeding 20° or 21° C. (68° or 70° F.), and by placing rubber caps on the tube before the culture medium had dried up. Where these precautions were not observed the plague bacillus died out in shorter periods. It, for instance, generally died out on agar when exposed for seven to eight days to a temperature of blood heat.

Effect on virulence of exclusive cultivation on artificial media.

Report of Austrian Plague Commission, Part II. C., p. 729, *seq.*

144. With regard to the maintenance of virulence in plague bacilli cultivated for prolonged periods exclusively on artificial media, the observations of the Austrian Plague Commission give us valuable information. The Commission tested the virulence of six out of a series of 27 cultures which had been cultivated exclusively on artificial media for a period of 14 months. Three of these were found to have retained their full virulence—one of the cultures which was found virulent being the culture spoken of above as having been found alive 470 days after it had been inoculated

upon agar. Of the three remaining plague cultures tested, two were found to be definitely attenuated, and the results with regard to the third culture were somewhat ambiguous.

145. The further question as to whether an alteration in the virulence can be effected by special modifications of the method of cultivation was carefully investigated by the Austrian Plague Commission. For the purposes of this investigation the plague bacillus was grown on agar for a series of generations, on the one hand, at very low temperatures (5° to 10° C., corresponding to from 41° to 50° F.) and, on the other hand, at a temperature of 36° or 37° C. (blood heat). Further it was grown at a temperature of 20° C. (68° F.), not only on neutral agar, but also on agar which had received additions of grape sugar (up to 5 per cent.), glycerine (5 per cent.), caustic soda (2 per cent.), and hydrochloric acid (0·7 per cent.). No alteration of virulence was achieved from any of these chemical additions. The cultivation at low temperatures was also quite without effect. On the other hand, a striking influence was exerted by growing the cultures at a temperature corresponding to blood heat Here, after cultivation had proceeded for a period of 43 days in a series of sub-cultures, the virulence was notably diminished.

Effect on virulence of cultivation in specially modified conditions.

Report of Austrian Plague Commission, Part II. C., p. 747, *seq.*

146. The plague bacillus appears effectively to resist exposure to the very extremest cold. Gladin reports that it survives exposure to a temperature of — 20° C. (— 4° F.). Similarly Kasenski reports that the plague bacillus was found alive in some of a series of cultures which were directly exposed to the cold of a Russian winter, when the thermometer registered 33° C. of frost (— 27° F.). We are told that the virulence of the bacteria in question was found to be reduced.

Effect of exposure of cultures to extreme degrees of cold.

Centralblatt für Bact., XXIV., 1898, p. 588.

Centralblatt für Bact., XXV., 1899, p. 182.

147. The question as to whether the virulence of the plague bacillus is affected, either in the direction of an exaltation or of an attenuation, by a series of passages through animals, has an obvious importance in connexion with the spread of plague. Mr. Hankin gave it as his experience that an exaltation of the virulence of the plague bacillus could be achieved by a series of passages through mice. The reverse of this held good of rats; in the case of these, Mr. Hankin found that the bacillus became rapidly attenuated, so much so that when he attempted to make a series of passages from rat to rat, without intercalating between the passages a series of cultivations on artificial media, his plague virus died out. Our experience with regard to this confirmed that of Mr. Hankin. The Austrian Plague Commission, who have investigated so many points in connexion with the variations in the virulence of the plague bacillus, do not appear to have paid special attention to this particular point. We note, however, on going through their experiments that a series of passages through rats, which was undertaken by them, was twice interrupted by the survival of the animals, these interruptions occurring in spite of the fact that cultures on artificial media were intercalated between the successive rat passages. It is just possible that the difficulty experienced in carrying through a series of passages in the case of rats may depend upon the very considerable resistance to infection which is manifested (quite independently of previous exposure to infection) by certain individual rats. On the other hand it is possible (though this would be somewhat difficult to reconcile with the fact that severe plague epidemics have occurred among rats, independently or almost independently of concurrent plague among men) that the bacillus of plague may undergo a certain amount of attenuation during its passage through each and every rat.

Effect on virulence of bacillus of passage through a series of animals.

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Report of Austrian Plague Commission, Part II. C., p. 767, Table 20.

148. We now pass to consider the naked eye and microscopical characters of plague as seen in artificial cultures.

Naked eye appearances of plague in artificial cultures.

In gelatine plates, at a temperature of from 20° to 25° C. (68° to 77° F.), colonies of the plague bacillus become sufficiently large to be visible to the naked eye after the expiration of from 48 to 72 hours. The gelatine is never liquefied. The colonies appear first on the surface in the form of fine transparent protuberances; these, when isolated, closely resemble drops of dew. When very numerous, they give to the plate an appearance which has been compared to that of a plate powdered over with glass dust. The surface colonies, when they are sufficiently isolated from each other to allow of their developing in an unrestrained manner, develop irregularly crenated margins. The individual colonies generally differ from each other in their rate of growth. Examined under a low power of the microscope, the colonies have a yellowish appearance in the centre where they are opaque, the border being transparent and glass-like. The colonies

Appearance of plague on gelatine plates.

in the depth of the gelatine develop later than on the surface. They form round, somewhat granular, clearly outlined, highly refracting, spherical, masses, becoming slightly darker as they grow older.

Appearance of gelatine stab-cultivations.

In gelatine stab cultures the bacillus grows uniformly along the whole track of the needle, forming a fine whitish streak which never increases very much in breadth. On the surface, however, the culture may spread, forming a superficial film over the gelatine. After some weeks, horizontal thready out-growths make their appearance in the upper half of the gelatine. In conformity with the fact that the plague bacillus grows more luxuriantly when it is freely in contact with the oxygen of the air, the outgrowths are always more numerous in the upper, than in the lower, part of the stab.

Special microscopical characters of bacilli derived from gelatine cultures.

Bacilli, when taken from young gelatine cultures, may show bipolar staining, and are found either singly, or united in twos as diplo-coccal forms. Occasionally the micro-organisms assume a filamentous form, such filaments being for the most part unprovided with transverse septa. Sometimes, however, septa make their appearance. Certain of the colonies which develop on gelatine are said by Dr. Klein to be composed exclusively 27,320. of filamentous forms. Considerable weight is laid by this observer on the development of a certain number of filamentous colonies, as an aid in discriminating plague from other micro-organisms.

Appearance of plague cultures on agar.

149. The plague bacillus grows luxuriantly on the surface of agar,—a pasty, irregular, streak, consisting of confluent colonies, developing in the course of 48 hours along the whole track of the needle. When the colonies are sufficiently separated out from each other, the margins are seen to be crenated; also, certain of the colonies are seen to develop more quickly, and to grow to a larger size, than their fellows. The cultures, when touched with the needle, are found to be distinctly sticky, it being possible to 8669. draw out the growth in the form of a glutinous thread. The stickiness of the plague cultures is said by some observers, in particular by Mr. Hankin, to be more marked in the case of virulent bacilli, freshly obtained from the animal organism, than in the case of bacilli which have been cultivated for prolonged periods on 17,276. artificial media. In addition to the characters described above, emphasis has been laid, in particular by Mr. Haffkine and his fellow workers, on a dull, specular, appearance seen in colonies grown upon dry agar, when these are viewed from behind, by reflected light through the nutrient medium. The appearance in question appears to us to 8667. depend merely upon the collection of moisture in and under the growing colony. Mr. Hankin informed us that he had, on the one hand, found plague cultures which did not give this characteristic appearance, and that he had, on the other hand, met with cultures of other micro-organisms which, when inoculated upon agar, gave a ground glass appearance indistinguishable from that produced by typical plague cultures. For these reasons, we are not disposed to attribute very much importance to this particular character as an aid to the discrimination of cultures of plague.

Special microscopic appearance of plague bacilli derived from agar cultures.

When agar cultures are examined microscopically, they are found for the most part to consist of isolated bacteria, interspersed with a certain number of diplo-coccal forms. When recently obtained from the animal organism, the individual bacteria for the most part show very distinct bipolar staining. In cultures of bacteria which have been grown upon artificial media for a number of generations, the central vacuoles are much less marked, if not entirely absent. In the case of cultures which have been incubated for several days there are often found, interspersed with the isolated bacteria and diplo-coccal forms, the degenerated bacteria spoken of as involution forms.

Involution forms as seen on agar.

150. Certain of these involution forms, apparently derived from isolated bacteria, assume appearances which remind the observer of yeast cells or amœbæ. Angular involution forms are also met with. Filamentous involution forms, however, are those most commonly found. These are three or four times as long as the undegenerated filaments seen in ordinary cultures and often terminate in swollen club-shaped extremities. The staining properties of all these various involution forms are extremely variable. In some cases they stain deeply with basic aniline dyes; in other cases staining takes place in an extremely irregular manner. In exceptional cases involution forms may remain quite unstained, even after long exposure to the action of basic aniline dyes. Characteristic involution forms are much more commonly found in the case of cultures recently derived from the animal organism than in the case of cultures which have been grown for a number of generations upon artificial media. These last may altogether fail to give characteristic involution forms.

Exaggerated productions of involution forms on salted agar. 8717.

151. Mr. Hankin made the important observation that when the plague bacillus is cultivated on an agar which contains from 2½ to 3½ per cent. of common salt, involution forms make their appearance earlier and in a more exaggerated manner than on ordinary agar. On salted agar, kept at a temperature of 37° C. (98°·4 F.), they often make their appearance within 24 hours; at a lower temperature, *e.g.*, at a temperature of 30° C. (86° F.), they make their appearance only after two or more days. Differences are observed in the cultures according as more or less salt has been added to the agar. In the case of plague bacilli inoculated on a medium containing a percentage of salt greater than the optimum (and this optimum seems to vary with the particular variety of medium employed), the bacilli do not proliferate and undergo a profound alteration in their morphological structure. The culture, when examined after 24 hours, shows exaggerated involution forms, consisting, for the most part, of large spheres and irregular pear-shaped bodies. When percentages of salt somewhat below the optimum are employed, there is much less inhibition of growth, and the extreme involution forms, which have been spoken of above, are comparatively rare. The most characteristic feature of such cultures is to be found in a uniform increase in size of the bacteria, so much so that, when a culture which has been grown on the medium in question is microscopically examined side by side with a culture grown on ordinary agar, the impression produced resembles that which would be associated with the substitution of a higher for a lower power of the microscope.

Ztschft. f. Hygiene, 1900, p. 495 *et seq.*

Important confirmation of the value of Mr. Hankin's test considered as a means for discriminating the plague bacillus from all other micro-organisms is afforded in a recent paper by Teisi Matzuschita. This observer, working under Gaffky, found that none of the many varieties of bacteria which he cultivated on salted agar gave anything like the exaggerated involution forms which are obtained in the case of plague.

Appearance of bouillon cultures of plague.

152. When the plague bacillus is inoculated into bouillon, the first appearances of growth are generally observable after a period of 24 hours. In exceptional cases, the culture medium becomes evenly turbid; much more commonly, growth appears in the form of delicate floccular masses on the surface of the culture medium. These for a time adhere to the sides of the containing vessel, but they sooner or later become detached, though, if the tube is left quite undisturbed, a delicate pellicle may in some cases spread over the surface. However, on the least agitation of the tube, portions of this pellicle become detached and fall to the bottom, leaving a trail behind them as they sink.

Special microscopical appearances of plague bacilli derived from bouillon cultures.

On microscopical examination of bouillon cultures, it is not uncommon to find, in addition to the isolated bacilli and diplo-coccal forms found in cultivations on solid media, long chains of bacilli which differ from strepto-cocci only in the fact that the bacterial chains themselves are less convoluted and that the individual elements are, as seen under a high power, ovoid rather than spherical. Such chains, though they may occasionally extend right across the field of the microscope, consist for the most part of not more than half-a-dozen elements. As in the case of agar cultures, so also in bouillon cultures, bacilli, both when isolated and when forming elements in diplo-coccal and strepto-coccal forms, can by suitable methods of preparation be seen to be surrounded by a mucilaginous capsular substance. Involution forms do not make their appearance in ordinary bouillon cultures.

Stalactitic form of growth. 27.

153. Mr. Haffkine has shown that if oil is introduced into the culture medium, the plague bacillus attaches itself to the floating drops of oil, and grows downwards from these in the form of tapering stalactites. These stalactites, like the pellicle spoken of above, become detached and fall to the bottom on the least agitation of the vessel. The growth in the form of tapering stalactites is apparently conditioned, firstly, by the circumstance that the plague bacilli as they grow adhere together by their glutinous capsules; secondly, by the circumstance that the new growth is, owing to the comparatively high specific gravity of the bacteria, necessarily carried downwards; and, thirdly, by the circumstance that the bacteria grow more rapidly and more luxuriantly on the surface, where they have freer access to oxygen, than in the depth of the culture medium, where there is less oxygen. These considerations have an important bearing on the question as to whether or not the stalactitic form of growth is absolutely characteristic of, and specific to, the plague bacillus. In connexion with 8663. this question we may note that Mr. Hankin informed us that he had met with a bacillus which formed stalactites which could not, by mere inspection of the culture, be distinguished from those formed by the plague bacillus. "The stalactites

obtained," said Mr. Hankin, "differed from those produced by the plague bacillus only in the fact that they were more resistant and stronger." In accordance with this, it would appear to be their length, and the readiness with which they are detached, which constitute the characteristic features of plague stalactites. Both these characteristics were seen in a beautiful manner in the cultures exhibited to us by Mr. Haffkine. Now, the development of these special characteristics must obviously depend, on the one hand, upon the strength of the glutinous matrix which holds together the masses of bacteria, and, on the other hand, upon the relation in which the specific gravity of the bacteria stands to the specific gravity of the bouillon in which they are suspended. Variation in both these respects is, of course, to be expected. Bearing directly upon 8662. this, is the circumstance that while plague bacilli which were isolated by Mr. Hankin from human beings, monkeys, and rats, at the commencement of the plague epidemic at Jawalapur gave typical stalactites, the stalactitic form of growth was no longer obtained with the plague bacilli isolated towards the end of the epidemic. The plague 8662. bacilli then obtained were found to sink rapidly to the bottom of the flask. Mr. Hankin imputed this difference in behaviour to alterations in the specific gravity of the plague bacillus. But it may have depended simply upon the employment in the second series of cultivations of a bouillon of a specific gravity less than that of the bouillon used in the first series. Or, again, as consideration will show, it may have 8669. depended upon a smaller development of the glutinous matrix (and it is interesting in this connexion to note that the cultures obtained by Mr. Hankin at the end of the Jawalapur epidemic were observed to be less sticky than the more virulent cultures obtained in Bombay and in the Hardwar epidemic). Whatever may have been the cause of the difference in the character of the cultures noticed by Mr. Hankin, his observations seem to to bring out clearly the fact that the successful development of typical plague stalactites is dependent on a somewhat delicate adjustment of the specific gravity of the medium to the specific gravity of the particular plague bacillus which is being cultivated.

III.(*c*).—*The Bacteriological Diagnosis of Plague by Microscopical Examination of Suspected Materials.*

Conditions under which a diagnosis of plague may be established by simple microscopical examination.

154. We may begin our consideration of the bacteriological methods by which the diagnosis of plague can be established by considering the question as to how far conclusions as to the presence or absence of the specific micro-organism of plague can be drawn from a simple microscopical examination of stained or unstained preparations of suspected material. In appraising the value attaching to positive and negative conclusions arrived at in this manner, we must bear in mind that plague bacilli may be present in the material examined even though they may be too few to allow of their detection by simple microscopical examination. For this reason no great weight, and indeed in some cases no weight at all, attaches to negative conclusions based on the non-discovery of the plague bacillus. In the case of a positive conclusion, based on a simple microscopical examination, the value attaching to it will be governed by the consideration that, while the morphological characters and staining reactions of the plague bacillus are, when they are developed in a typical manner, sufficiently distinctive to allow of this bacillus being discriminated from all other pathogenic bacteria found in the mammalian organism, they are not sufficiently distinctive to allow of the plague bacillus being differentiated from all the other species of bacteria which are found in external nature. Thus quite different values will attach to the result of a microscopical examination, according as the material which is examined consists of (*a*) blood or pus or exudation fluid taken directly from the organism of a man or animal showing suspicious symptoms, or (*b*) excretions derived from sick men or animals, or (*c*) material obtained elsewhere than from the animal organism.

Inferences that can be drawn from microscopical examination of lymph or pus from buboes and contents of blisters.

155. In the case of material obtained directly from a bubo, or from a blister or other lesion of the skin, the presence of micro-organisms showing the morphological characteristics of the plague bacillus will, especially if the characteristic micro-organisms are present in large numbers, amount to strong presumptive proof that the case from which the material under examination has been derived is one of plague. On the other hand, the non-discovery of bacteria possessing the morphological characters of the plague bacillus will not necessarily negative the diagnosis of plague. Especially will it not negative such a diagnosis in cases where the material has been obtained by the puncture of a bubo in the very early stages of its development. In such circumstances the actual gland may have been missed, and the surrounding tissues may not yet have been invaded by plague bacilli. Again, in

the later stages in the development of the bubo—and the same applies also to the case of the blister—contaminating micro-organisms may have effected an entrance and may have proliferated to such an extent as to supplant the plague bacillus Cases of this sort will, however, be exceptional, and in most cases a positive or negative diagnosis of plague can be based with practical certainty upon the discovery or non-discovery of characteristic forms of micro-organisms by a simple microscopical observation of the material obtained by puncturing the inflamed lymphatic gland.

Inferences that can be drawn from microscopical examination of blood.

156. In the case of the blood derived from a patient who is suspected of suffering from plague, the detection of bacteria possessing the morphological characters of the plague bacillus will (especially if these are present in large numbers, and when it is determined that these become decolourized by Gram's procees) be conclusive evidence that the patient is suffering from plague. The mere finding of a few isolated bacteria arranged together as diplo-coccal forms cannot, especially when Gram's test has not been applied, be accepted as establishing the diagnosis of plague. We have in view here in particular certain suspected cases which occurred in Calcutta in 1896, in which it was claimed by Professor Simpson that the diagnosis of plague was confirmed by his bacteriological examinations. We would note with regard to these, first, that in some of the suspected patients only a few isolated diplo-coccal forms were found after long searching through a number of films prepared from the blood. Again, in view of some of the figures reproduced in the record of Dr. Simpson's evidence, particularly figures I., VI., C. and F., it is important to note that it does not seem to have been determined whether the bacteria became decolourized when treated by Gram's process, and, lastly, the fact must not be lost sight of that saprophytic diplo-cocci of various kinds are widely distributed in nature, and that there is always a possibility of microscopical preparations containing as contaminations a small number of such diplo-coccal forms. Whilst the finding in blood of bacteria showing typical morphological and staining characters (always supposing a sufficiency of such bacteria have been found) will be conclusive as to the presence of plague, the non-discovery of such bacteria will not in any way rebut a diagnosis of plague based upon clinical symptoms. This will be manifest when it is considered that, unless in a period immediately antecedent to death, plague bacilli will rarely be present in large numbers in the blood.

III. 369-76.
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Inferences that can be drawn from simple microscopical observation of the excretions.

157. In dealing with the question of the microscopical examination of the excretions, we may confine our attention to the sputum, which is the only excretory material in which plague bacilli are likely to be found in sufficient numbers to allow of their detection by microscopical observation. In the case of typical primary plague pneumonia, there will rarely be any difficulty in establishing the diagnosis by the microscopical examination of the sputum ; the presence in large quantities of isolated bacteria or diplo-coccal forms showing a central vacuole is in most cases quite sufficient to place the diagnosis beyond question. A certain amount of difficulty may, however, arise on the one hand in cases where the plague bacilli have undergone degenerative changes, and on the other hand in cases where the sputum contains many pneumo-cocci. In this last case it will be difficult to arrive at a certainty that the preparations contain, in addition to the pneumo-cocci which retain the stain when treated by Gram's process, also the diplo-cocci of plague which become decolourized.

Inferences that can be drawn from microscopic examination of material grossly contaminated with saprophytic bacteria.

158. In dealing with material derived elsewhere than from the human or animal organism, it will be impossible to arrive at a diagnosis of plague by a mere microscopical examination. It is true that Lieut.-Colonel Lawrie, I.M.S., and Mr. Stevens, the Deputy Plague Commissioner for the Hyderabad State, have claimed that the plague bacillus can be readily detected in the floor materials of infected houses by the aid of the microscope alone. Indeed, Lieut.-Col. Lawrie and Mr. Stevens went so far as to assert "that the infection of plague could be tracked about by means of the microscope with as much certainty as if it were visible to the naked eye," and that the infectivity or otherwise of a house could by these means be determined. It was contended that the results of simple microscopical observation were in some cases confirmed in the Hyderabad State Laboratory by subsequent cultivation and by inoculation tests. Doubt, however, is cast on the value of the confirmation in question by a study of the technique employed, and by a consideration of the negative results which have, as will be seen below, invariably been obtained by other observers who have endeavoured to detect the plague bacillus in soil. Even if in some particular cases the bacteria isolated in the Hyderabad State Laboratory really were plague bacteria, the method of simple microscopical examination would, none the less, be

I. 447.

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quite fallacious as a method for general use, seeing that, as has already been incidentally mentioned, there are to be found in ordinary earth many different diplococcal forms, some varieties of which show a central vacuole. We have found such forms to be numerous in earth obtained from places in India which were, so far as was known, free from plague infection. We have found them also in street dust and in mud collected from the sea-shore in Egypt.

III.(*d*).—*The Bacteriological Diagnosis of Plague by Cultivation Methods.*

Diagnosis of plague by means of cultivations; advantages and disadvantages of the method generally.

159. The above ends our consideration of the microscopical diagnosis of plague. The employment of cultivation methods as aids to the diagnosis of plague comes under consideration, firstly, in connexion with the detection of the plague bacillus where it is present in material uncontaminated by other bacteria, and, secondly, in connexion with the isolation of the plague bacillus when it is intermixed with contaminating micro-organisms. About the first of these points, it will not be necessary to say more than that, where microscopical examination is not conclusive in the case of a material which contains only very few plague bacilli, we can, by inoculating on to a nutrient medium, cause the contained bacilli to develop into colonies which shall be macroscopically visible, with the result that their detection becomes a perfectly simple matter. It might be supposed that we should gain a similar advantage by inoculation on to a nutrient medium in cases where the material under examination contained plague bacilli in admixture with contaminating micro-organisms. Generally, however, it is the very reverse of this which obtains. For many varieties of contaminating micro-organisms exert on the plague bacillus an influence in restraint of growth. This influence, which operates in such a manner as to prevent, or almost prevent, the development of plague colonies, makes itself felt even when, as in plate cultivations, the contaminating bacteria have been comparatively widely spaced out. Among the pathogenic micro-organisms found in the human organism, the strepto-coccus pyogenes, the pneumo-coccus of Frænkel, and no doubt others, exert this influence on the plague bacillus, colonies of plague rarely making their appearance in plates where there is an admixture of these micro-organisms. A similar inhibitory action on the growth of the plague bacillus is exerted also by many of the non-pathogenic micro-organisms which are distributed universally in nature. The bacillus subtilis, the bacillus mesentericus, the micro-coccus prodigiosus,—all of which are practically ubiquitous—exert such an inhibitory influence. An even more marked inhibitory influence is exerted by the bacillus coli, which is constantly found both in material derived from the human organism and in material elsewhere derived. Much remains to be elicited with regard to the nature of this inhibitory influence. In the case of the bacillus coli the German Plague Commission, in view of the result of their experiments, are inclined to attribute the influence exerted by this bacillus to the circumstance this it grows faster than the plague bacillus, and uses up all the nutrient material in the culture medium. The Austrian Plague Commission also adopt this view. The retarding influence of the bacillus coli would, however, appear to be at least in part due to the fact that some of the products of the metabolism of that bacillus (possibly the acid products) are injurious to the plague bacillus. Contrary to what was found by the Austrian Plague Commission, we found that the growth of the plague bacillus was markedly retarded when it was inoculated on to agar which had been flushed with a filtrate obtained from a bouillon culture of the bacillus coli. Whatever be the explanation of the inhibitory influence which is exerted by this and so many other micro-organisms on the growth of the plague bacillus, it is, at any rate, certain that we have here a very formidable obstacle to the isolation of the plague bacillus from material containing a large admixture of other micro-organisms.

Report of German Plague Commission, p. 260.

Report of Austrian Plague Commission, Part II. C., 639-40
26,150

Advantages and fallacies of cultivation methods as applied to the examination of—
(*a*) lymph or pus from blisters or pustules;

160. Passing now from the consideration of general principles to the consideration of the conclusions which can be drawn from the positive and negative results of cultivations made from suspected materials we may deal first with cultivations instituted with material derived from phlyctenules or other skin lesions. While cultivation methods have here an advantage over methods of simple microscopical examination in the fact that the plague bacteria may be increased in number, and while they have a further incidental advantage in the fact that the rate of growth and the appearance of the cultivation supply valuable data for judging of the nature of the micro-organisms, it must be borne in mind that contaminating micro-organisms, supposing such to be present, may completely inhibit the growth of the plague bacilli.

In conformity with these considerations, a positive result obtained by the employment of cultivation methods will be more conclusive than a positive result obtained by simple microscopical examination; on the contrary, a negative result, where contaminating micro-organisms make their appearance in the culture, will, considered as evidence of the absence of the plague bacillus, be even less conclusive than a negative result obtained by simple microscopical examination.

(*b*) material derived from buboes;

Exactly the same statement holds true with regard to material derived from buboes. In other words, while the advantages which attach to the employment of cultivation methods will be conspicuous in cases where contaminations are not present, fallacious conclusions may be drawn in cases where a growth consisting only of contaminating micro-organisms is obtained.

(*c*) blood;

In the case of the blood the advantage of the cultivation method over the method of simple microscopical examination comes out most clearly, a positive result being frequently obtained in cases where the plague bacteria would, owing to their small numbers, have escaped detection on simple microscopical examination. The utility of this method of diagnosis is, however, limited by the consideration that positive results can be obtained only after that stage of the disease has been reached at which the bacteria invade the blood stream. Even then success will in many cases be secured only when the quantities of blood employed for the cultivation are, relatively speaking, considerable. The chances of securing colonies of plague bacilli in the culture are manifestly much better when 5 or 10 c.c. of blood are employed than when merely one or two drops of blood from a prick in the finger are inoculated on to the nutrient medium. Even when sufficient blood has been taken for cultivation purposes from a plague case which has reached the septicæmic stage, fallacious negative results may be obtained, if contaminating bacteria, such as the pneumo-coccus and streptococcus, are present in the blood and inhibit the growth of the plague bacillus. Another point which deserves mention is that the number of plague colonies which develop in the culture are often much fewer than the number of plague bacteria seen on microscopical examination of the blood.

(*d*) excreta and material only indirectly derived from the animal organism.

In the application of methods of cultivation to the detection of the plague bacillus in excreta and material derived elsewhere than from the animal organism, it is to be borne in mind that, owing to the large number of contaminating micro-organisms which have to be dealt with, the difficulties of isolating the plague bacillus are enormous. The magnitude of the difficulties which have to be confronted will appear clearly when we consider the conditions under which the plague bacillus has to be sought for in grossly contaminated substances. Taking, for instance, the case where the plague bacillus is sought for in material derived from the cowdung and earth floors of native houses, we may take note of the fact, brought out in Dr. Marsh's experiments, that one gramme of floor material taken from inhabited houses contains, 18,805. on the average, something like three millions, and, in exceptional cases, up to eight millions, of saprophytic micro-organisms. The isolation of an individual plague bacillus from a gramme's weight of such material would thus involve (1) the mechanical separation of this bacillus from, say, three millions of contaminating bacteria, *i.e.*, the spacing out of the plague bacillus to such a distance from the contaminating bacteria as would take it beyond the sphere of influence of those which would inhibit its growth; (2) the scrutiny of each of the three millions of colonies; and (3) the microscopical examination and further testing of all such colonies as might present any of the characteristics of plague colonies. It will be obvious that the ordinary methods of isolation by means of plate-cultivation would here prove quite impracticable. In spite of these considerations, we did examine, by 27,137. the method of plate-cultivation, seven specimens of earth taken from plague-infected houses. From these specimens we isolated four different kinds of bacilli, whose microscopical appearance resembled that of plague, but each of these, when further investigated, presented points of difference from the plague bacillus.

Experiments made to test a method of isolation proposed by Mr. Hankin.

161. Finding the discovery of the plague bacillus in earth by ordinary methods impracticable, we addressed ourselves to the task of testing a method of isolation which had been suggested by Mr. Hankin, and for which was claimed by Dr. Shrinavasa Rau that it enabled the plague bacillus to be isolated from fæces and other grossly contaminated material. The method in question consists in inoculating the material Vol. II., p. 8. to be tested into a series of tubes of bouillon, which have received graduated additions 8,594.

of 1 to 8 drops of a reducing mixture, consisting of ferrous sulphate, 10 parts; tartaric acid, 10 parts; citric acid, 1 part; water, 100 parts; the whole made alkaline with ammonia. Before instituting experiments to determine whether the plague bacillus could be recovered by this method from suspected earth, or from earth which had been artificially contaminated with plague, we made preliminary experiments to determine whether the plague bacillus, when added in pure culture to bouillon tubes containing the reducing fluid in the quantities prescribed by
26,129. Mr. Hankin, could afterwards be recovered by cultivation. We were uniformly unsuccessful in our attempts to recover the plague bacillus from tubes of bouillon which had received the prescribed additions of Mr. Hankin's re-agent. In view, however, of the fact that Mr. Hankin had succeeded in this, we undertook a further series of experiments to see whether the plague bacillus could be isolated by this
26,139. method from the floors of infected houses. Ten specimens of material from earth and cowdung floors, and one specimen of dust from a cement floor, all taken from rooms from which plague cases had just been removed, were examined by mixing the material into sterile broth and inoculating from this mixture into a series of tubes of bouillon containing from 1 to 5 drops of Mr. Hankin's solution. From four of the 11 samples of floor material examined, bacilli possessing some of the morphological characters of the plague bacillus were recovered, but the bacteria recovered, when tested by inoculation into animals, proved to be altogether devoid of pathogenic power. Interpreting this result in the light of our failure to recover the plague bacillus when added in pure cultivation to Mr. Hankin's medium, and bearing in mind the wide distribution of vacuolated diplo-coccal forms in earth, it seems to us that the isolation method which is here in question is one upon which no reliance can be placed.

Attempt to isolate the plague bacillus by cultivation in an atmosphere of carbonic acid gas.

162. In view of our want of success with this method, we determined to try the effect of cultivating a mixture of plague bacilli and contaminating micro-organisms in an atmosphere of carbonic acid gas. We were induced to do this by the consideration that Dr. Marsh had in certain experiments found the plague bacillus to develop in the form of luxuriant strepto-coccal chains in cultures which had been buried in the soil, and also in cultures which were grown in an atmosphere charged with carbonic
26,144-5. acid. The time at our disposal did not allow of our testing this method in any adequate way, but we think it noteworthy that we succeeded in recovering the plague bacillus by this method in two out of three specimens of unsterilised garden soil which had been artificially infected with a culture of the plague bacillus. The method employed was to introduce a small quantity of the infected unsterilised garden earth into a tube of sterile broth; the tube was then drawn out in the flame, and a stream of carbonic acid was passed through; this done, the tube was sealed; it was then incubated for from four to seven days. On making zigzag strokes on agar from tubes treated in this manner, in the two instances referred to colonies of plague bacteria were obtained. These, when inoculated into animals, caused death
26,434*b*. with typical symptoms, the plague bacillus being recovered from the blood. In another series of experiments in which some infected earth was inoculated into six broth tubes in the manner indicated, certain of the colonies obtained consisted of a bacillus which morphologically resembled plague. The bacillus in question, however, had no pathogenic properties, producing no symptoms even when inoculated in considerable doses in the peritoneal cavity of mice. It could, therefore, not be
26,141. identified with the plague bacillus. Again, in another series of experiments, when seven specimens of earth derived from plague-infected houses were examined by the method described, from two specimens bacilli morphologically resembling the plague bacillus were obtained. Owing to our departure from Bombay, the nature of these bacilli was not further investigated.

General conclusions as to methods of cultivation employed for detection of plague bacillus in contaminated material.

163. It will be seen from the above that there is as yet no cultural method which can be depended upon to reveal the presence of plague bacilli when mixed with large numbers of contaminating micro-organisms. Where, therefore, negative results as to the presence of plague are obtained from the examination of fæcal, or other grossly contaminated, material, it will not be legitimate, from these negative results,to infer that the plague bacillus is really absent from the material examined.

Special supplementary methods of cultivation applicable for the

164. We have to deal now with the employment of certain special supplementary methods of cultivation for the further identification of such cultures as may have been obtained in the preliminary cultivations, which we have up to this time been considering.

Identification of the plague bacillus after it has been obtained in pure culture.

To verify the nature of the culture obtained, inoculations may be made into ordinary agar, gelatine, and bouillon, with a view of seeing whether the growth develops the features described above as associated with the growth of the plague bacillus in these several media. There is, as we have seen, nothing absolutely characteristic in these features, although valuable indications may be obtained from the rate of growth, the irregularity of the contour of the isolated colonies, the varying size of these, and the stickiness of the culture. The floccular growth in broth, and, in microscopic preparations, the bipolar staining, the isolated or diplo-coccal form of growth, the size of the bacillus, and, further, the presence of certain thread-like and other involution forms, constitute, when taken together, a sufficiency of characters to establish the diagnosis with all but absolute certainty. In addition to planting out the culture on ordinary media, it may with advantage be planted out also on salt agar and on bouillon to which an addition of oil has been made with a view to obtaining the characteristic involution and stalactitic forms described above. For the purpose of rapid diagnosis the former of these two characters is, however, the more valuable, the stalactitic growth requiring an interval of at least a certain number of days for its characteristic development.

III.(*e*).—*The Bacteriological Diagnosis of Plague by the Aid of Inoculation Experiments.*

On the inoculation of animals considered as an aid to the discovery of the plague bacillus.

165. The inoculation of highly susceptible animals is a method which may be resorted to, on the one hand, with a view to isolating the plague bacillus from a mixture of contaminating micro-organisms, and, on the other hand, with a view to determining whether a micro-organism which has been isolated by cultivation methods from suspected material is, or is not, a plague bacillus.

Subcutaneous inoculation considered as a method for the isolation of the plague bacillus from material grossly contaminated with saprophytic bacteria.

166. We may conveniently deal, first, with the employment of inoculation for the former purpose. In view of the difficulties which are, as we have seen, in the present state of our knowledge, associated with all attempts to isolate the plague bacillus by cultivation methods from material grossly contaminated with saprophytic bacteria, many observers have sought to achieve the isolation of the bacillus by inoculating the suspected material into the subcutaneous tissue of highly susceptible animals, such as rats, mice, and guinea pigs. This method has been employed by Mr. Hankin in an extensive series of investigations instituted with a view to collecting information with regard to the distribution of the plague bacillus in external nature. 8588–9. After a wide experience, Mr. Hankin is impressed by the great uncertainty of the results obtained by subcutaneous inoculation. He found that, where cultivation methods have failed to disclose plague, the method of inoculation will occasionally give positive results; 8522–4. on the other hand he found that the method of inoculation may give negative results, even when plague bacilli are present in quantities which would 8586. be sufficient to kill the animal if separately inoculated.

Employment of the method by Mr. Hankin with the view to the isolation of the plague bacillus from materials derived from an infected house.

167. A detailed description like the following, which we have extracted from an official report by Mr. Hankin, of an actual experiment on material obtained from a plague-infected room, brings out the untrustworthiness of the method of subcutaneous inoculation in a very striking manner. The material in question was obtained from a house in Cross Lane, Currey Road, Bombay. "Professor Muller," says Mr. Hankin, "found this house while carrying out his plague inspections. He kindly telephoned for me, and I arrived about an hour after he had left. On opening the door of the single room, about ten feet square, that was inhabited by the family, he found three persons, the mother and two daughters, lying on the floor suffering from plague. The mother and one daughter were at once taken away to hospital. The other daughter, a girl of about eight years old, died while they were removing her, and the body was left in the corner of the room. The father, Dattu Koli, a mill-hand, had died on the preceding day. Another child had died four days earlier. Thus the whole family had been carried off. On entering the ill-ventilated room I found it in a great state of disorder. Clothes, food, and filth of all sorts covered the floor. In one corner was the cooking place and numerous brass vessels. Another corner was occupied by the nanee or drain, in which were some human dejecta. Another corner contained an altar with a brass image of Ganesha, the God of Wisdom. The body of the little girl was in the other corner. The room was pervaded by an overpowering smell that produced

nausea. I spent about an hour collecting specimens in the room, and also helped the Sanitary Inspector to burn the clothes and property. I arrived at my laboratory within an hour of leaving the place, and immediately proceeded to inject extracts of the specimens I had collected into mice. The specimens of earth of the mud and cowdung-floor were all taken from the surface and at places in which traces of dejecta were visible.

"The following is a list of injections made into mice :—

Number of Mouse.	Substance Injected.	Result.
1	Earth from floor	Death after 24 hours.
2	,, ,,	,, 96 ,,
3	Another specimen of earth	,, 24 ,,
4	,, ,,	,, 24 ,,
5	,, ,,	Survived.
6	,, ,,	,,
7	,, ,,	Death after 48 hours.
8	,, ,,	Survived.
9	,, ,,	Death after 48 hours
10	,, ,,	,, 8 days.
11	Stain of dried saliva found on a stool	Survived.
12	,, ,, ,,	Death after 18 days.
13	Water in brass lota on floor	,, 72 hours.
14	,, ,,	,, 5 days.
15	,, in large degchie	Survived.
16	,, ,,	,,
17	Dejecta from corner of drain	Death after 24 hours.
18	,, ,,	,, ,,
19	Millet found between grindstones	,, ,,
20	,, ,,	Survived.
21	Stain on clothing (? vomit)	Death after 25 days.
22	,, ,,	Survived.
23	Drain outside house	Death in 48 hours.
24	,, ,,	,, after 5 days.
25	Dust from bamboo lamp-frame over shrine	Survived.
26	,, ,, ,,	,,
27	Stain of saliva mixed with betel on edge of drain	Death in 24 hours.
28	,, ,, ,,	Survived.
29	Dust from a shelf	,,
30	,, ,,	Death in 24 hours.
31	Canvas sacking used as bedding	,, ,,
32	,, ,,	,, after 12 days.
33	Salt found in an earthen pot	Survived.
34	,, ,,	,,
35	Partly eaten pudding made of rice on floor by corpse (*sic*)	,,
36	,, ,, ,,	,,
37	Washings of three cigarettes found on the floor	,,
38	,, ,, ,,	,,

"Of the 20 mice that died mentioned in the above table, 17 were subjected to further examination by inoculation into a second series of mice. In each case the spleen was ground up in bouillon, and two or three drops inoculated into mice. Of the 17 mice of this second series, only four died. From each of these four mice other mice were inoculated, some with quantities of the spleen, others with only traces. Altogether in this experiment 94 mice were inoculated. Numerous agaragar cultures were inoculated from the spleens and other organs of every mouse that died.

"The plague microbe was not detected in a single case, although there is every probability that the room was badly infected. The microscopic appearances in mice, Nos. 10 and 31 were somewhat suspicious of plague, but no plague microbes could be isolated. With regard to mouse No. 24, that had been inoculated from dirt in the drain outside the house, passages were made from its spleen through three mice. From the last of these mice a microbe was isolated that gave involution forms somewhat similar to those of plague, but it grew on agaragar more vigorously than plague, and did not respond to Pfeiffer's serum test."

168. We find it difficult, in view of facts like these, and other similar facts, with regard to both mice and rats, placed on record by Mr. Hankin, to adopt Mr. Haffkine's view that the subcutaneous inoculation of contaminated plague-infected material into rats is "an exceedingly sensitive method" for the purpose of isolating the plague bacillus from infected earth. Indeed, the consistently negative results of the soil-examinations which were instituted by Dr. Gibson in Mr. Haffkine's laboratory would seem of themselves to afford proof of the untrustworthiness of the method of subcutaneous inoculation, considered as a method for the isolation of the plague bacillus from a mixture of contaminating micro-organisms.

Conclusions arrived at with regard to the method of subcutaneous inoculation considered as a method for the isolation of the plague bacillus.
153.
619–20.

169. With a view to avoiding the fallacies inseparable from inoculations which involve, as those which we have been considering do, the introduction into the subcutaneous tissue of large numbers of contaminating bacteria, many of which may have pathogenic properties, various other methods of inoculation which are less open to objection on this score have been resorted to. The German Plague Commission resorted in many instances to inoculation on to the conjunctiva. Yersin, Roux, and others, have proposed inoculation on to the mucous membrane of the nose. The Austrian Plague Commission speak very favourably of inoculation on to a shaved and scarified skin-surface. These various methods of inoculation will come up for consideration again in connexion with the discussion of the channels by which plague bacilli may obtain access to the body. In the present connexion it will suffice to note that, except in the case of inoculation on to a scarified skin surface, which appears in the hands of the Austrian Plague Commission to have been very successful, very little experience is yet to hand as to the value of the methods in question, considered as methods for isolating the plague bacillus from a mixture of contaminating micro-organisms.

Consideration of other methods of inoculation designed to achieve the isolation of the plague bacillus.
Report of German Plague Commission, p. 284.
Report of Austrian Plague Commission, Part II. C., *passim*.

170. The question of the employment of inoculation into animals as a means of confirming a diagnosis of plague arrived at by microscopical examination, or by this last in combination with cultivation methods, can be disposed of in a few words. The following points would appear deserving of special note. The death of the inoculated animal is not, unless in cases where plague bacilli are found in its blood or spleen, to be regarded as confirming a diagnosis of plague. Mice and guinea pigs would appear to be the most suitable animals to employ for inoculation experiments. Rats, as already indicated above, would appear to be less suitable, inasmuch as they, in certain instances at least, show a considerable amount of resistance to plague.

Employment of inoculation for the purpose of confirming a diagnosis arrived a by other methods.

III.(*f*).—*The Serum Diagnosis of Plague.*

171. When once Widal had shown that typhoid fever could be discriminated from other specific fevers by the method of serum-diagnosis, which Gruber and Durham had previously exploited in the case of inoculated animals, the question of the possibility of employing the same method of diagnosis in the case of plague immediately presented itself.

Question as to the application of the method of serum-diagnosis to the discrimination of plague from other diseases.

The German Plague Commission, in particular, undertook the investigation of this question. From the investigations undertaken by them it appears to result that agglutinating substances are in point of fact produced in the system of animals and men who have suffered from plague, and also of animals who have been repeatedly inoculated with dead plague cultures. On the question as to whether the presence of these agglutinating substances in the blood is of assistance in the diagnosis of doubtful cases, the German Plague Commission express themselves somewhat guardedly. They would seem to recognise that the practical utility of this method of diagnosis is considerably limited, firstly, by the fact that definitely negative results are not infrequently obtained in the case of persons convalescing from plague; and secondly, by the fact that the bacteria in a plague culture are, even in the absence of a specifically active serum, so massed together into clumps as to make it a matter of difficulty to determine by microscopical examination whether agglutination has, or has not, been produced by the addition of serum. With a view to overcoming this last difficulty the German Plague Commission recommend that the sedimentation, as distinguished from the agglutination, of the bacteria under the influence of the serum should be taken as the criterion of a positive reaction.

Investigation of the question by the German Plague Commission.
Report of German Plague Commission, p. 321, *seq.*

In connexion with the employment of the method as an aid in the differentiation of plague bacteria from other bacteria, we note that Mr. Hankin appears in two or

Employment of the method by Mr. Hankin and

Captain Leumann respectively.
8587 ; 8672.
3196, *seq.*

three instances to have had recourse to the serum-test for this purpose. We are not informed as to whether the results he obtained were unambiguous.

The statements of Captain Leumann, I.M.S., with regard to the presence of agglutinins in the blood of persons inoculated twice, and the absence of these substances in the blood of persons inoculated once, with Haffkine's prophylactic, must, we think, be discounted in view of serious defects in the technique employed by the witness in the experiments on which he based his conclusions.

Difficulties and fallacies of serum-diagnosis as applied to plague.

We think that the difficulties and fallacies of the serum-diagnosis of plague, though they are recognised by the German Plague Commission, have not been sufficiently emphasized by them. The serum-diagnosis of plague is rendered uncertain, not only by the fact that plague bacilli are normally agglomerated together into masses by the intermediary of their glutinous capsules, but also by the fact that these agglomerated masses, when they become detached, normally sink to the bottom of the containing vessel. It is thus, unless in cases of specially rapid sedimentation, practically impossible to be sure that a specific action is being exerted.

Our personal experience of the method.

Our personal experiences in the matter of the practical exploitation of the serum-diagnosis of plague were extremely disappointing. We were quite unable to satisfy ourselves of the presence of specific agglutinating and sedimenting powers in the blood, either of plague convalescents, or of persons who had been inoculated with Haffkine's plague vaccine. More than this, we were unable to satisfy ourselves as to the presence of any agglutinins in either of the two consignments of antiplague sera which were kindly furnished by the authorities of the Pasteur Institute in Paris. In conformity with this we are of opinion that no practical value attaches to the method of serum-diagnosis in the case of plague.

IV.—MODE IN WHICH THE PLAGUE BACILLUS EFFECTS AN ENTRANCE INTO THE HUMAN AND ANIMAL ORGANISM.

IV.(1.).—*Mode in which the Plague Bacillus effects an Entrance into the Human Organism in the Bubonic and Septicæmic Forms of Plague*

Mode in which the plague bacillus effects an entrance into the human and animal organism.

172. We may commence our consideration of the question as to how the infective material of plague makes its way into the organism by dealing with the human organism. We may consider, in the first place, how the bacillus of plague makes its way into the system in cases of bubonic and septicæmic plague.

Proof of entrance of infective material through breach of skin surface afforded by cases of plague resulting from accidental introduction of virus at post-mortems into wounds.
Para. 191 of this Report.

Conclusive evidence of the possibility of the infective material entering by a breach of the surface of the skin is afforded by the fact that the disease has in many cases been contracted by the direct inoculation of the virus in the course of post-mortem examinations on plague patients. We have collected particulars of no less than 13 cases (11 of these being cases occurring in India) in which the disease was contracted in this manner. A brief summary of the history of each of these cases will be found in a subsequent section of this Chapter. As is shown there, in some of the cases in question infection took place through abrasions of the finger, or through partially healed scars ; in other instances, again, infective material was inoculated by a prick with the point of a knife, or by a scratch inflicted by a projecting spicule of bone. In some cases the scratch in question was, it may be remarked, so slight as to pass quite unnoticed at the time at which it was inflicted. The cases in question afford conclusive proof that the infection of plague is very readily contracted when the virus comes in contact either with a broken surface of skin or when it is subcutaneously inoculated.

The occurrence of local reactions noticed in only two of the above cases.

173. It is important, in connexion with the question of the occurrence of a local reaction after the inoculation of plague virus into the skin, to note that in 11 of the 13 cases referred to, most of which came directly under the observation of medical men, it is either specifically stated that there was no reaction at the site of inoculation, or the record is silent on the matter. In the two remaining cases a small phlyctenule developed at the site of inoculation. The details with regard to these two cases in which phlyctenules developed are important.

Case of Dr. Sticker.
Snow's Report on Plague in Bombay, 1896-7, p. 127.

In the first case, that of Dr. Sticker, a member of the German Plague Commission, the infective material appears to have obtained access to the system by an unnoticed scratch inflicted on the hand when conducting a post-mortem examination. The first definite indication of infection was a certain amount of general malaise. Following upon this a small vesicle developed in the hand. A burning and pricking sensation made itself felt in the region of the vesicle. Shortly afterwards definite lymphangitis, associated with lancinating pains in the arm, set in. Plague bacilli were detected in the contents of the vesicle.

Case of Captain Leumann, I.M.S. 4542, *seq.*

In the second case, that of Captain Leumann, I.M.S., the infective material appears to have effected an entrance through a scratch contracted in the course of a post-mortem made on a plague patient. The first symptom of the disease was a kind of mental aberration; the next was a painful swelling of the glands of the axilla; subsequently to this a bleb developed at the site of the scratch. The contents of the bleb were examined for plague bacilli with negative results.

Details of cases in which similar local reactions occurred, apart from a history of local introduction of infective material. I. 374.

174. Captain Childe, I.M.S., communicated to us the four following interesting cases:—

"B., Hindu man, age 40, came to hospital on 5th October, 1896. Three days before he had been seized with fever, and shortly afterwards found pain and swelling in the left axilla. On admission he looked very ill, temperature 103, and there was a large bubo in the left axilla. On the outer side of the left forearm near the wrist there was a small papule the size of a pea, with hair growing through it; it was slightly red at the base, contained a little serum at the apex and was partly covered by a scab. It was not painful, and the patient knew nothing about it; there were no inflamed lymphatics leading from it. Cultivations were made from the serum squeezed from the papule and a typical growth of plague was obtained. Part of the culture was injected into a rat, and the rat died of plague after 60 hours. On the same date, 5th October, cultures were made from the finger blood, but all remained sterile. This man died on 8th October.

"N. S., Hindu man, aged 28, came to hospital December 1st, 1896. There was a large bubo in the vertical set of the right inguinal glands. He said he had been ill three days. There were many old cracks and fissures about the feet and toes, the skin being thick and horny, and some scratch marks on both legs. On the outer surface of the right calf there was a slightly raised œdematous portion of skin about one inch long, and on it there was a small bleb, the size of a large pin's head. From the bleb some thin serum was squeezed out. Cultures were made from the fluid in the bleb and from the finger blood. A pure growth of the plague bacillus was ultimately obtained from the bleb, whereas the cultures of the blood remained sterile. The patient could give no history of the œdematous patch on the leg, and there was no pain in it.

"N., Hindu man, aged 30 years, was admitted on March 3rd, 1897, with a bubo at the back part of the right axilla. He had been ill two days. On the back, near the angle of the right scapula, there was a papule, the size of a pea, on a slightly reddened base, and partly scabbed over; it looked like a pimple which had been scratched. Cultures were made from the serum squeezed from this papule and from the finger blood; pure growth of the plague bacillus was ultimately obtained from the papule, but the cultures of the finger-blood remained sterile.

"P., Hindu boy, aged 16, admitted on October 26th, 1896. On either side several of the oblique inguinal glands were enlarged to the size of walnuts, and painful. There was a small unopened papule on the glans penis exactly in the dorsal middle line; its apex contained a little pus and serum. It did not look at all like a chancre, and the boy said he knew nothing about it. Cultures were made from the papule and from the finger blood. From the former a pure growth of plague was ultimately obtained. This was injected into a rat, and the rat died of plague. Cultures of the finger-blood remained sterile. This patient recovered."

Annales de l'Institut Pasteur, October 1898.

Report of German Plague Commission, p. 265.

The four cases just cited, even if they stood alone, would suffice to establish that infection may, under natural conditions, be contracted by the channel of the skin, and this, so far as can be discovered, independently of the existence of any previous wound or breach of continuity of the skin. Vesicles such as those which came under observation in these cases are not very uncommon in cases of bubonic plague. Dr. Simond gives a list of 61 cases of plague in which vesicles were observed at the presumptive site of inoculation. In each of these cases the plague bacillus is said to have been found in the contents of the vesicle. The German Plague Commission give particulars of 11 cases where primary vesicles were observed. Plague bacilli were detected in only three of these cases.

No inference as to frequency of infection through skin surface can be deduced from hospital statistics with regard to occurrence of local inflammation of skin.

175. Coming now to the question as to whether any estimate can be formed of the frequency of infection from the skin, it would, at first sight, seem that inferences of value might possibly be arrived at by inquiring in what percentage of cases a local reaction, either in the form of a phlyctenule, or in the form of a pustule or carbuncle originating in a phlyctenule, has been recorded at the site of inoculation. Consideration will, however, show that an estimate based on data of this nature must necessarily be fallacious. In the first place, as the histories of the cases infected while making post-mortem examinations indicate, phlyctenules develop at the site of inoculation only in

a very small percentage of cases. In the second place, as will appear from the four cases cited above from Captain Childe, the local reaction at the site of inoculation may, when present, be so insignificant as to be very readily overlooked. In the third place, reflection will show that the development of a phlyctenule (that is, the development of a serous effusion between the upper and lower layers of the epidermis) could only be expected in cases where the virus is deposited in that particular situation. Now this can manifestly occur only in a very small minority of cases. Ordinarily the virus will be inoculated directly into the subcutaneous tissue. In such a case no phlyctenule will be developed, for such serous effusion as takes place will take place below the epidermis.

Frequency with which buboes develop in connexion with lymphatics from skin surfaces establishes frequency of infection through skin.

App. I. to this Report.

If we want to learn in what percentage of cases infection has been contracted through the skin, we must inquire what percentage of primary buboes develop in connexion with lymphatics which stand in anatomical relation to external, as distinguished from internal, surfaces. Now the salient fact in connexion with the distribution of the buboes which are found in plague is, as will be seen on reference to our Statistical Appendix, that primary buboes practically always develop in connexion with lymphatics originating in the skin, and that it is only in the very rarest cases that primary buboes develop in connexion with lymphatics originating in the mucous membranes of internal surfaces. The broad inference which we can draw from this fact is, plainly, that the system is invaded, for the most part, not from internal surfaces, but from the skin.

This inference confirmed by relative frequency of buboes in different regions of the body.

This inference is confirmed when we realise that primary buboes are found with greater or less frequency in the various regions of the body according as larger or smaller areas of skin surface drain into the glands of the regions in question. In this connexion the following figures, extracted from Vierordt's tables, may be considered:—

Area of Skin covering different Regions of the Body.

Head - - - - - - -	803 sq. cms.
Neck - - - - - - -	456 „ „
Trunk - - - - - - -	2,491 „ „
Upper extremity - - - - -	1,998 „ „
Lower extremity, including the pelvis - -	5,016 „ „

With a view to obtaining from these figures some sort of a rough estimate of the area of skin surface which stands in connexion with the lymphatic glands in each separate region of the body, we may make the assumption that half of the lymphatics of the trunk drain into the glands of the arm-pit, and that the other half drain into the glands of the groin. Working on this assumption, we obtain the following figures for the areas of skin surface which stand respectively in relation with the cervical, axillary, and inguinal, glands:—

Glands of the neck receive lymphatics from an area of -	1,259 sq. cms.
Glands of the arm-pit receive lymphatics from an area of -	3,244 „
Glands of the groin receive lymphatics from an area of -	6,261 „

It will be seen that the areas of skin surface which drain respectively into the glands of the neck, the axilla, and the groin, stand to each other approximately as the figures 1 : 1·8 : 5.

App. I. to this Report.

If now we consider the hospital statistics published in our Statistical Appendix, which set forth the numbers of primary buboes in the neck, axilla, and groin, observed in Bombay, Karachi, and the Punjab, respectively, we shall find that the numbers of cervical, axillary, and inguinal, buboes recorded in the three sets of hospital statistics stand to each other severally in the relations expressed by the figures 1 : 2 : 7, 1 : 1 : 5, and 1 : 1·3 : 5·5. Aggregating the figures for the three hospitals, we find that the relations in question are expressed by the figures 1 : 1·3 : 5·8. There is an extremely striking coincidence between these figures and those which express the relation between the superficial areas of the regions whose lymphatics drain into the respective groups of glands.

Inference as to channel of infection drawn from comparison between plague persons who wear shoes and those who go bare foot.

176. Though this would appear to be quite unnecessary, further confirmation of the conclusion that the infective material enters through the skin has been sought also in other directions. In particular, comparisons have been instituted between the prevalence of plague in persons who are accustomed to wear shoes and in persons who are accustomed to go bare-foot. A comparison, instituted by Dr. Aoyama in Formosa, between the Chinese, who walked bare-foot, and the Japanese, who wore shoes, is said

to have shown that buboes in the groin were more frequent in the former. Material for instituting the comparison in question does not appear to exist in India. It is true that the lower class of natives walk bare-foot in the streets, while the higher class natives wear shoes; but a comparison based on this would be vitiated by the fact that it is a common practice among all classes of the native population to walk bare-foot in the house. And it is in the house, rather than in the street, that infection is likely to be contracted. Again, though it might be possible to institute a comparison such as is here contemplated between natives who walk bare-foot in the house and Europeans who do not adopt this practice, such a comparison would be of little value, not only because the statistical data would, in the case of Europeans, be drawn from too small a number of cases, but also because there are many points of difference between the European and the native, other than the wearing or discarding of shoes, which might exercise an influence on the distribution of buboes.

Possibility of infection through the channel of the nose and throat.

177. The question as to whether there are channels other than the skin through which the plague bacillus effects an entrance into the system may unhesitatingly be answered in the affirmative. In favour of the view that the infective material may in some cases obtain access to the system through the mucous membrane of the nose, mouth, or pharynx, are: first, the fact that the infection of plague can, in animals, be experimentally produced by the inoculation of the plague bacillus on the mucous membrane of the nose; secondly, the fact that in man buboes under the chin and about the angle of the jaw are not at all uncommon; thirdly, the fact that the plague bacillus has been found in the human patient in association with primary inflammatory lesions of the tonsils and of the mucous membrane of the nose and the pharynx; lastly, certain epidemiological facts appear to speak in favour of the possibility of the bacillus entering the system by means of the mucous membrane of the nose, such as the fact that, in certain places, epidemics which have been diagnosed as epidemics of mumps preceded and may possibly have stood in casual relation to epidemics of plague. Again, in one instance at least, there is, as we shall see hereafter, reason to suspect that an epidemic of severe coryza may have stood in causal association with a subsequent epidemic of plague.

Para. 317 of this Report.

Possibility of infection through the channel of the conjunctiva.

178. Infective material may gain access to the human organism also by the conjunctiva. In this connexion we may refer to the fact that a case of plague occurred in an English nurse in the Parel Hospital, Bombay, as the result of accidental contamination of the conjunctiva by sputum coughed up by a patient suffering from pneumonic plague. The clinical symptoms of the case, in particular the fact that inflammation of the conjunctiva set in, and that this was followed by the appearance of an enlarged gland just below the ear on the affected side, make it clear that the disease was really contracted through the channel of the conjunctiva.

7215.

We have learned unofficially of a similar case of infection which occurred in Hong Kong, also in the person of a nurse.

Possibility of infection by the channel of the stomach and intestinal tract.

179. We have not been able to discover any facts which would support the suggestion that plague may effect an entrance into the human organism through the channel of the stomach or intestinal canal. If infection takes place at all through this channel, it can be only in the very rarest instances.

Possibility of infective material effecting an entrance into the organism through mucous membranes of the genital tract and anus.

180. We may pass to consider the possibility of infective material effecting an entrance into the organism through the mucous membranes of the genital tract and anus. The possibility that infection may be contracted through the former of these channels is suggested by cases where plague phlyctenules have made their appearance on the glans penis (one of these cases has been detailed above), and further by the fact that three patients are alleged to have contracted the infection in the Parel Hospital through the channel in question. The possibility of such a mode of inoculation has been confirmed by experiments on animals.

Para. 173 of this Report.

22,264.
18,113.
25,778.

Our attention was drawn by Lieut.-Colonel Henderson, I.M.S., to the possibility of the infection of plague being conveyed by means of the earth balls which fulfil in Bombay the daily office which is served by ablutions in other parts of India.

IV.(2.).—*Mode in which the Plague Bacillus effects an Entry into the Human Organism in Primary Plague Pneumonia.*

Possibility of infection by means of the lungs and

181. The question as to whether plague can be contracted by the inhalation of infective material into the respiratory tract comes prominently into consideration in connexion with the causation of primary plague pneumonia.

respiratory system generally.

In favour of the view that there is a direct inter-relation between the inhalation of infective material and the supervention of primary plague pneumonia, is, on the one hand, the localisation of the disease in the lungs, and on the other hand, the circumstance that plague pneumonia can be produced in animals by the conveyance of plague-infected material into the respiratory passages, either by intra-tracheal injections, or, though with less certainty, by the deposition of the infective material on the mucous membrane of the nose.

Difficulties in assumption that plague pneumonia caused simply by inhalation of infective material of ordinary plague.

182. On the other hand, it must be noted that there are difficulties in the way of assuming a simple inter-relation between the inhalation of plague bacteria into the lungs and the supervention of primary plague pneumonia

Doubt based on small proportion of pneumonic cases among disinfectors. 10,340.

The first difficulty that confronts us is the fact that primary plague pneumonia has apparently been of extremely rare occurrence among disinfectors, who are by the nature of their occupation very much exposed to the inhalation of dust. On the theory that plague pneumonia is due to the inhalation into the lungs of the infective material of ordinary plague, it would have been reasonable to expect to find a large number of cases of the pneumonic form of plague among the disinfecting staffs.

Further doubt suggested by fact that proportion of plague pneumonia to total plague cases varies greatly in different epidemics or different phases of the same epidemic.

A second difficulty presents itself when we consider the statistics which set forth the proportion in which cases of primary plague pneumonia have stood to the total of plague cases in different epidemics in India. For if the relation between the inhalation of plague bacteria into the lungs and the production of plague pneumonia was a simple and defined relation, like that which obtains between the introduction of plague-infected material into the legs or arms and the subsequent development of a bubo in the groin or arm-pit, the proportion of cases of primary plague pneumonia ought to stand to the total plague cases in a relation not less constant than that in which buboes in the groin or axilla stand to the total of bubonic cases.

Statistical evidence from hospitals. App. I. in this Vol.

But, while a study of the figures in the hospital statistics published in our Statistical Appendix, which set forth the proportion of buboes in the various regions of the body, shows that this proportion is wonderfully constant, a study of the figures which set forth the proportion of primary plague pneumonia to the total of plague cases indicates that this last proportion is subject to great variations.

Further doubt suggested by facts with regard to particular plague epidemics. Para. 203 of this Report. 11,163.

This indication is confirmed by such facts as have been supplied to us regarding the relative proportion of pneumonic cases to the total of plague cases in certain places. In Backergunge, the detailed history of which is given in a subsequent section, all the cases which occurred were, without exception, cases of primary pneumonia. In the case of Gharibabad, the plague cases are said to have been "generally of the type of pneumonia plague." Again, in other epidemics, or more accurately in certain phases of certain epidemics, there has been a very marked excess or absence of primary plague pneumonia. There appears to have been almost complete absence of pneumonic cases in Bangalore towards the latter end of the epidemic of 1898–9. This appears also to have been the case in Bombay in the early months of 1899. Here, although the epidemic was at its height during the period in question, we failed to find a single definite case of primary plague pneumonia. Dr. Choksy, speaking with an experience which extends over four epidemics in Bombay City, and which embraces a total of 6,000 plague cases, notes that plague pneumonia "exists variably in different epidemics; in no two does it appear in anything like a fixed ratio." We may instance Ankleshwar, Hyderabad (Sind), Kotri, Nasik, Porbandar, and Satara, as places where pneumonic cases were few.

Bombay Medical and Physical Society, Sept. 1900.
14,268, 18,093–4, 18,151–3, 12,700, 14,705–11, 13,724–7, 22,153.

Doubt arising from absence of history of origination of primary plague pneumonia from contact with bubonic case, and from frequency of successive cases of primary plague pneumonia.

Differences such as those mentioned above in the proportion of cases of primary plague pneumonia obviously do not conform with the theory that the introduction of plague bacilli into the lungs is the only factor which comes into play in the production of this type of plague. But perhaps the inadequacy of the view that there is a simple inter-relation between the introduction of plague infective material of ordinary plague into the lungs and the supervention of plague pneumonia is most clearly established by the fact that we were unable, though we made special inquiries into this matter, to discover any definite instance of primary plague pneumonia having originated from contact with a case of ordinary bubonic plague. In the large majority of cases where a history of infection was obtainable, that history has pointed to an origination of primary plague pneumonia from a previous case of pneumonic plague. Noticeable examples of this are detailed in the history of the epidemic in Backergunge, and also in connexion with certain other minor epidemics of plague pneumonia to which attention is drawn in a subsequent section of this Chapter.

Paras. 202–3 of this Report.

Adequate theory of origin of plague pneumonia must take into consideration:

183. We, therefore, must endeavour to substitute for the theory that there is a simple inter-relation between the introduction of plague bacteria into the lungs and the supervention of primary plague pneumonia a more adequate theory.

firstly, special conditions of form and manner in which infective material may be communicated from pneumonic patients;

We must take into consideration the possibility that there may be something, either in the form, or in the manner, in which the infective material escapes from the body, which favours the conveyance of the infection into the lungs of persons in attendance on cases of plague pneumonia. We have incidentally seen that opportunity for the direct transference of infective material to attendants is afforded by the fits of coughing to which pneumonic patients are subject. Opportunities for indirect transference are afforded by the circumstance that sputum may readily become desiccated and pulverised, and that it may in this condition readily be inhaled into the lungs.

secondly, that something specific in infective material of plague pneumonia causes pneumonic plague.

Paras. 202-3 of this Report.

A second possibility which must be kept in view is that there may be something specific in the infective material which conditions the supervention of plague pneumonia when the material is introduced into the lungs. This view would appear to win support, firstly, from the circumstance that instances are on record of the outbreak of pneumonic plague among persons who have attended the funerals of patients who had died of pneumonic plague, and, secondly, from the circumstance that in the Dharwar Hospital where "unfortunately a pneumonia case was left in the same ward with two other patients suffering from the bubonic form, these two, who at the time were doing well, developed pneumonic symptoms within 48 hours, and both died. From the above," says Dr. Hornabrook, who reports the case, "it will be seen that the pneumonic type of plague is dangerous even to a patient suffering from the bubonic fever."

Necessity for further inquiry and suggestions regarding lines along which inquiry might proceed.

The questions opened up by the above observations would appear to be deserving of future investigation. With a view to indicating the paths along which that investigation might appropriately proceed, we may perhaps call attention to the following.

1517, 12,997, 13,177, 15,182, 15,280, 16,048, 17,990, 18,214, 4567, 9566, 7218.

There can be no question of any specific difference between the plague bacillus which gives origin to cases of plague pneumonia and the bacillus which gives origin to cases of bubonic plague; for our inquiries have elicited that cases of bubonic plague have not infrequently originated from contact with cases of primary pneumonic plague.

It is, on the other hand, possible that there may be a difference in point of virulence between the plague bacillus which causes pneumonic plague and the plague bacillus which causes bubonic plague. Against this, however, may be urged the fact that the third epidemic in Bombay was at its maximum of virulence at a time when plague pneumonia was absent.

Again, it is possible that the plague bacillus may, in the case of infective material derived from a pneumonic case, be associated with some other bacillus which favours its growth and contributes to the production of plague pneumonia; in favour of this would appear to be the fact that, in many cases of plague pneumonia, pneumo-cocci, strepto-cocci, and other pathogenic bacilli, have been found associated with the plague bacillus; against this may be urged, though this is not conclusive, that plague bacilli have in some instances, on microscopical examination, appeared to have been present in pure cultivation in sputum. The great difference in the character of the symptoms in different cases appears also to suggest that primary plague pneumonia may be a mixed infection, in which the secondary rôle may be played at one time by one micro-organism, at another time by another. Lastly, we may note that it has been suggested, from a survey of the pathological changes in the lungs, that pneumo-cocci may in many cases be agents in preparing the way for a subsequent development of the plague bacilli in the lungs.

Report of German Plague Commission, p. 74.

IV.(3.).—*Mode in which the Plague Bacillus effects an Entrance into the Organism of Rats.*

Mode by which the plague bacillus effects an entrance into the organism of rats.

184. We pass now to the discussion of the mode in which the plague bacillus effects its entrance into the organism of rats, this question being of great importance in view of the fact that rats play a great part in the dissemination of the infection of plague.

Possibility of the infection being contracted by rats through the channel of the skin.

In the case of rats, as in the case of men, we have first to consider the possibility of the infective material effecting an entrance into the organism through small wounds in the skin. That the bacillus can invade the rat organism in this way emerges clearly from the results of inoculation experiments. The only questions which arise for discussion, therefore, in this connexion are, first, as to what quantity of the infective material is required for communicating the disease, and, secondly, the question as to whether rats infect themselves in a state of nature through the channel of the skin.

Report of German Plague Commission, p. 282.
Report of Austrian Plague Commission, Part II., C., p 684.
26,311.

With regard to the first of these questions, the German Plague Commission state that in their experience a mere prick with a plague-infected needle suffices to bring about the death of an ordinary rat. The Austrian Plague Commission, while noting that the inoculation of small quantities of very virulent cultures is almost always followed by fatal results, record that in isolated instances rats showed no reaction to the inoculation of very considerable quantities of fully virulent cultures. We ourselves (and we were dealing with cultures freshly isolated from fatal cases of plague) found that it was in all cases necessary to inoculate a very sensible quantity of plague culture in order to ensure the death of the animal, and in some cases we found evidence of great resisting powers on the part of the rats with which we had to deal in Bombay.

Section IV. (4) of this Chapter.

The data which are available with regard to the post-mortem appearance of rats do not permit of a final judgment being arrived at as to whether the system is generally invaded in a state of nature through the channel of the skin. In a certain proportion of cases buboes are found which seem to indicate cutaneous infection. It has been suggested that rats communicate the infection to each other by means of bites, but the circumstance that the bodies of rats are enveloped in a close covering of hair would seem to afford, at any rate, a large measure of protection against cutaneous wounds. It has been suggested also that the infection may be inoculated into rats by fleas. This question, involving as it does the general question of conveyance of plague by insects, will be treated of in a subsequent section of this Chapter.

Possibility of rats being infected through the channel of the alimentary canal.

185. The results of experiments which relate to the possibility of infection through the channel of the alimentary canal are of a very conflicting nature.

Negative results were obtained by Dr. Gibson, Mr. Hankin, and Dr. Simond, who have all experimented on this subject.

619; 635-44.

The details of Dr. Gibson's series of experiments are of great interest. He prepared the 10 rats which he used for the experiments by keeping them without food for 24 hours. He then fed them on small bundles of corn, wrapped in pieces of gunny bags, and then soaked in a broth cultivation of plague which was found to be sufficiently virulent to kill in 36 hours when inoculated hypodermically into rats in a dose of 1 c.c. The bundles of corn which were supplied to the rats that formed the subject of the feeding experiments were given to them in a moist condition. The supply of infected food was renewed as occasion required for about a fortnight. At the end of that time the rats, though each had consumed from 100 to 150 c.c. of the original plague culture, all remained well. Subsequently, with a view to testing their resistance, they each received hypodermically 1 c.c. of the plague culture in question, with the result that they all succumbed to plague in 36 hours.

8691-2.

Mr. Hankin made experiments with similar negative results. He is of opinion that rats contract plague from the intestinal canal only when large quantities of very virulent cultures are introduced into their food.

Annales de l'Institut Pasteur, Oct. 1898.

Dr. Simond's experiments go even further in this direction. In one experiment he caused a rat to drink a watery suspension of plague bacteria which he made from a virulent agar culture of plague. In another experiment he fed a rat for three consecutive days on virulent agar cultures, one of these being administered daily. In certain further experiments he fed rats upon the organs and dead bodies of animals which had died of plague. In other experiments, again, rats were fed with pneumonic sputum, and with food that was soiled with infected blood. In each and all of these experiments the rats remained healthy.

Report of the German Plague Commission, p. 284.

The German Plague Commission, on the contrary, found that plague could be conveyed to rats by feeding them on plague cultures or the bodies of rats dead of plague. They infer from this, that in a state of nature rats generally become infected in this manner. They suggest, however, that in such cases the infective material may penetrate into the system through the mucous membrane of the throat or nose, and not through the mucous membrane of the alimentary canal.

Report of Austrian Plague Commission,

The Austrian Plague Commission found that rats could easily be infected by feeding them on plague-infected material. The pathological changes found in the body after death pointed in most cases to the penetration of the bacillus through the mouth, and only in rare cases to the penetration through the intestinal wall. They found, however, that not all rats could be infected with plague by the mouth. Out of seven rats which were repeatedly fed in Bombay on plague-infected material, three remained alive. Part II., C., p. 684.

In view of the above, we think that it is quite possible that rats may occasionally, under natural conditions, contract plague by feeding either on the dead bodies of their companions, or on grain or other food contaminated with plague excretions, or, as has been suggested by gnawing the dead bodies of plague patients. 7185. We think, however, the results recorded by Dr. Gibson, Mr. Hankin, and Dr. Simond, justify the conclusion that the infection of rats through the alimentary canal cannot be very common.

Possibility of the infection being contracted by the channel of the nose and the respiratory tract generally.

186. The results of experiments, in which plague bacilli have been placed in contact with the uninjured mucous membrane of the nose, place it beyond doubt that plague bacteria may effect an entrance into the rat organism by this channel. There is, however, a difference of opinion among observers as to whether rats are more easily infected in this manner than by hypodermic inoculation. While some observers are of opinion that rats are more susceptible to infection through the mucous membrane of the nose, other observers are of the contrary opinion. 8703. Among these is Mr. Hankin, who is disposed to think that rats are not particularly susceptible to infection by the mucous membrane of the nose. Our own experience, which is a very 26,311. restricted one, is in conformity with that of Mr. Hankin. In two cases where we filled up the nostrils of rats with a broth culture of virulent plague, the rat remained perfectly healthy. We think, however, we were not justified in inferring from these cases that infection may not in nature often be contracted through this channel. Of all channels of infection this seems to us the most likely in such cases, for instance, as those where an outbreak of plague among rats appeared to have been traceable to an importation of plague-infected clothing. Para. 271 of this Report.

IV.(4.)—*Question as to the Transference of Plague Infection by the Agency of Suctorial Insects.*

Question of the transference of plague by the agency of suctorial insects from rat to rat and from rat to man.

187. It has, in the case of plague, as also in the case of many other septicæmic diseases, both of animals and of men, been suggested that infection may be transferred from the sick to the healthy by the agency of suctorial insects. In particular, the suggestion that insects may be instrumental in the spread of the plague has been mooted as furnishing a possible explanation of the extraordinary number of attacks which, as we shall see, are recorded among the Jains, a Hindu sect with whom it is an article of religion not to take any form of life, even that of insect parasites. Para. 300 of this Report. The suggestion that insects take an active part in the dissemination of plague has, however, been most prominently put forward in a paper on the spread of plague, which was published by Dr. Simond. Annales de l'Institut Pasteur, Oct. 1898.

Inductive process by which Simond endeavours to prove such transference.

188. Dr. Simond conceives that fleas which have been parasitic on plague-infected rats migrate on the death of their hosts, and convey infection to healthy men and rats. With a view to establishing the conveyance of the infection by the agency of insects, and the importance of this agency, Dr. Simond endeavours to establish the following:—

Firstly, that plague rats are eminently infective when infested with fleas, and that they cease to be infective when they have been deserted by their parasites;

Secondly, that living plague bacilli are found in association with fleas which are taken from plague-infected rats;

Thirdly, that plague can pass from infected rats to other animals which have not come directly in contact with them or with their infected excretions; and

Fourthly, that the fleas which infest rats will transfer themselves as parasites to men.

Pre-eminent infectivity of rats immediately after death not clearly established.

With a view to proving that plague rats are very infectious immediately after death, Dr. Simond recites certain occurrences which point to infection having been contracted by handling rats which were recently dead of plague. It will not be necessary to detail these occurrences here; we shall come upon them in a subsequent section of this Chapter, which deals with the general question of the infectivity of plague-infected rats. Section VI.(5)(*a*) of this Chapter. We may here so far anticipate as to say that, on a survey of the whole of the facts, the particular point which Dr. Simond endeavours to prove does not appear to be clearly made out.

No proof that decline of infectivity follows on desertion of rats by insect parasites.

To establish the proposition that rats cease to be infectious shortly after death, Dr. Simond cites the fact that, in an isolated experiment made by him, a batch of seven rats remained healthy after they had been placed for 24 hours in contact with the corpse of "a plague rat found dead in the city of Karachi and deserted by its parasites." It will be seen that the pre-eminent infectivity of rats which have recently died of plague, as compared with rats which have been dead somewhat longer, is far from being established by an isolated observation like this. Even if this particular point were hereafter to be established, there would be no necessity for assuming that the decline of infectivity was due to the abandonment of the rats by their insect parasites. A simpler explanation would be furnished by the gradual desiccation of the infective material on the external surface of the corpses, and the gradual dying out of the plague bacilli in the interior of the organism.

Presence of plague bacteria in fleas does not prove possibility of further transfer of the bacteria by fleas to other animals.

With a view to establishing that living plague bacteria are found in association with fleas which have been parasitic on plague-infected rats, Dr. Simond adduces three observations. In each of the experiments in question an extract, made by triturating fleas taken from plague-infected rats, was injected into a mouse. The three mice which were thus inoculated succumbed, but only in one case was proof obtained that the death was due to plague. The proposition that living plague bacteria are found in association with fleas taken from plague-infected animals rests, then, so far as Dr. Simond is concerned, upon a single positive result. But even given that the evidence of this single positive result were conclusive, it would, as consideration will show, establish only that the plague bacillus may be taken up by the flea from the plague-infected rat, and it would not suffice to establish that the plague bacillus may be further transferred from the flea to another animal.

Dr. Simond put forward the view that the further transference of the plague bacillus by the flea to its new host is probably effected by the inoculation of the flea's dejecta into puncture wounds produced by the flea's bites. To establish the possibility of this, it would be necessary to show that living plague bacilli are found in the flea's dejecta. No experiments on this question are to hand, but we would note that the careful experiments of Dr. Nuttall, in the parallel case of bugs, have demonstrated that plague bacilli, when taken into the body of these insects, are in process of time destroyed there.

Johns Hopkins Hospital Reports, VIII., Oct. 1899, p. 18.

Inconclusive nature of experiments made to prove transfer of plague by fleas from rats to other animals.

Passing now to the consideration of the experiments which Dr. Simond adduces in proof of his proposition that plague can be transferred by the agency of fleas, we have to deal with a series of four experiments. In each of these experiments a healthy animal (in three cases a rat, and in the fourth case a mouse) was placed in a cage which was introduced into a glass vessel in which a rat was dying of plague. With the design of ensuring that opportunity should be afforded for the transference of plague from the dying to the healthy animal by the agency of parasites, a certain number of fleas had previously been placed in the glass vessel. Of the animals experimented upon, one rat and one mouse contracted plague; the other two rats remained healthy. We may note here, first, that fleas obtained from cats were selected as agents for the transfer of the infection, without apparently any inquiry as to whether the fleas which are parasitic on cats will transfer themselves as parasites to rats or mice. It is thus not certain that the infection can, in the cases where the animals experimented upon died, have been conveyed by the agency of the insect parasites in question. We may further note that we do not gather from the description of the arrangements that precautions were adopted to prevent infected dejecta being projected by the struggles of the dying animal through the bars into the cage containing the healthy animals. It is thus not impossible that the infection may have been conveyed directly by ordinary mechanical agencies from the sick to the healthy animals.

Uncertainty whether rat fleas transfer themselves to men.

Under the fourth of the headings set forth above no experiments are adduced by Dr. Simond, the observer contenting himself with a statement that he had satisfied himself that rat fleas will transfer themselves to men. The Hon. Lionel Rothschild, to whom, as having a special knowledge of insect parasites, we, by the advice of Prof. E. Ray Lankester, referred the question for an opinion, thought it possible that such a transference might in exceptional circumstances occur. Professor Galli Vallerio, on the other hand, was unsuccessful in his attempt to induce rat fleas to transfer themselves as parasites to men. There would thus appear to be some uncertainty as to whether rat fleas will, as Dr. Simond suggests, freely transfer themselves to men.

Centralblatt f. Bact. 6.1.1900 and 28.12.1900.

Conclusion regarding evidence adduced by Dr. Simond.

It will have become manifest that the process of induction by which Dr. Simond endeavours to establish the proposition that suctorial insects play an important part in the transference of plague from sick to healthy animals is so weak as to be hardly deserving of consideration.

We are thus left to consider the suggestion in the light of other experimental evidence.

General considerations regard transfer of bacterial diseases by suctorial insects.

Johns Hopkins Hospital Reports, VIII., Oct. 1899.

189. The evidence dealing with the general question of the transference of infection by the agency of insects has been very ably summarised by Dr. Nuttall in a critical and historical study already cited above. It appears, from the data which are collected together in that publication, and in particular from the careful and extensive series of experiments with anthrax, plague, chicken-cholera, and mouse septicæmia, that were performed by Dr. Nuttall himself, that no experimental evidence can be adduced in support of the theory that suctorial insects play an important part in the transference of bacterial diseases from one animal to another. It will perhaps be appropriate to cite here the following results obtained by Dr. Nuttall in his experiments on plague. "Twenty-two bugs which had sucked the blood of a mouse dying of plague (the blood contained many bacilli) were immediately placed on four mice. None of the mice sickened after being bitten by the infected bugs." In the case of anthrax—a disease in which the bacteria are, as in plague, present in large numbers in the blood—Dr. Nuttall's experiments were again entirely negative. His experiments were carried out on mice, which are extremely susceptible to anthrax. Eight mice bitten by 124 infected bugs all remained healthy. Uniformly negative results were obtained by Dr. Nuttall also in his experiments with chicken-cholera and mouse-septicæmia.

The experience of Plague Hospitals in India, and in particular the experience obtained in the Arthur Road Hospital at Bombay, seems to indicate very clearly that suctorial insects do not come under consideration in connexion with the spread of plague. Dr. Choksy in particular drew attention to the fact that the staff and attendants in the Arthur Road Hospital were continually bitten by insects, especially mosquitoes, and that none the less no cases of the transfer of infection from the sick to the healthy came under observation.

20,640–1.
20,999–21,004.

V.—The Incubation Period of Plague.

Length of incubation period of plague.

190. In accordance with the scheme laid down at the outset of this Chapter, we now pass on to consider the question of the length of the incubation period of plague, a question the determination of which has an importance not only theoretically in connexion with the epidemiology of plague, but also practically in connexion with the measures adopted for combating the disease.

Information which makes it possible to fix the incubation period of plague can be drawn from various sources.

Class I.A. Precise evidence available in histories of infection contracted at post-mortems.

The most precise information available is derived from the histories of certain cases in which the disease has been contracted by persons who were either making, or assisting, at post-mortems on plague patients. Not less precise is the information available from the consideration of a case, already referred to, in which plague supervened upon the inoculation of infective material upon the conjunctiva, and of a case reported by Captain Leumann, I.M.S., where plague followed the bite of a delirious pneumonic patient. We have enumerated below in tabular form under the heading of Class I., Group A. the particulars of the cases referred to. In each of these cases not only is the exact time when the virus was inoculated fixed by the history, but in many of the cases there is, in the fact that a bubo subsequently developed in relation with the site of the inoculation, evidence that the virus inoculated on the occasion in question was the real cause of the disease.

Class I.B. Important confirmatory evidence derived from histories of cases which came into contact with infection on a particular specified occasion.

In Class I., but under the separate heading of Group B., we have collected cases of persons who, having been previously unexposed to infection (or practically so), came specially in contact with infection on a particular specified occasion and not afterwards. Under this heading are included cases where a plague attack has occurred subsequent to a visit to an infected house, or subsequent to contact with plague-infected persons or rats. The information available in these cases is less valuable than the information derived from the consideration of the cases of accidental inoculation, inasmuch as it does not supply actual proof of the presence of infective material or of its coming in contact with some susceptible surface. None the less, as the historical presumption that the disease was contracted on the occasion specified is in most of the cases enumerated in Group B. a very strong one, these cases would appear to afford important confirmation of the inferences that can be deduced from the consideration of the histories of the cases enumerated under Group A.

Class II. Information as to extreme limit of incubation period available from histories of persons who were continuously exposed to infection from a particular date onwards.

Supplementary information as to the duration of the incubation period can be derived from the histories of persons who, having been previously quite unexposed to infection, or practically so, can be shown to have been from a particular date onward more or less continuously in the presence of infection. Cases such as are here in question are grouped together below in tabular form under the heading of Class II. We have under this heading enumerated among others (*a*) cases of persons arriving from uninfected places who have come into attendance upon plague-infected persons; (*b*) cases of persons who, living in previously uninfected localities, have, from a particular date onward, come in contact with imported infection; (*c*) cases of persons who, living in previously uninfected houses, have from a particular date onwards been exposed to infection introduced into those houses by plague-infected rats; and (*d*) cases of persons, who, while previously living in the presence of infection, have, from a particular date onwards, become more susceptible to infection by the fact that they have accidentally wounded themselves. Cases such as these, though they do not, like the cases enumerated in Class I., enable us to fix the beginning as well as the end of the incubation period, will manifestly assist in the determination of the duration of the incubation period by virtue of the fact that the interval which elapsed between the first exposure to infection and the supervention of the disease, cannot in these cases have exceeded in duration the incubation period and must in a large majority of cases have been less than the incubation period.

Class III. Indications which can be derived from histories of persons who developed plague after removal from infected surroundings.

Lastly, indications with regard to the duration of the incubation period can be derived from the consideration of the cases which we have grouped together under Class III. The cases referred to are those of persons who, having previously been continuously in contact with infected surroundings, have been removed from those surroundings on a particular date. Indications of the kind here in question are afforded by the records of segregation and evacuation camps, which set forth the number of plague attacks developed in camp and the dates of those attacks. The information obtained from consideration of the cases grouped together as Class III. is, as we shall see hereafter, of very little assistance to us in fixing the duration of the incubation period.

Class I., Group A.

191. We may now proceed to set forth, in the form of a brief synopsis under these various headings, the facts that we have collected with regard to the duration of the incubation period.

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CLASS I.

CASES which allow of both the BEGINNING and the END of the INCUBATION PERIOD being ACCURATELY FIXED.

Group A.—Cases where there is a History of a Direct Inoculation of Infective Material.

Serial Number.	Authority.	Reference.	History of Case.	Length of Incubation as deduced from History.	Remarks.
1.	Evans	6923-5, 6988-95	The patient in question, a Dome, assisted at the post-mortem examination of a plague patient on 27th and 29th April, and 1st May 1898. On the last date he got a scratch; fever was noticed in the evening of the 2nd, and the patient died of plague on the 3rd.	24-36 hours.	
2.	Elphick, also Chaytor-White	9566, 9393	Patient, an Assistant Surgeon, on the 17th of January 1898, at the post-mortem on a pneumonic patient, scratched himself on the back of the right hand; plague manifested itself in 36 hours, fever setting in on January the 19th. The glands on the right side of the chest were enlarged.	36 hours.	

Serial Number.	Authority.	Reference.	History of Case.	Length of Incubation as deduced from History.	Remarks.
3	Cook	6462, 6493	Patient, a Dome, at 8 a.m. on 17th April 1898, scratched his hand at the post mortem of a plague case in Calcutta. At noon on 19th he was found to have fever, and plague declared itself.	2 days.	
4	Clemow	7218	Patient, a Hospital Assistant, pricked a finger of his left hand at 3 p.m. on March the 14th, during the post mortem on a case of plague pneumonia. On the evening of the 16th he felt ill, and plague set in with enlargement of the left supratrochlear gland, and a bubo in the left axilla.	2 days.	
5	Clemow	4562–9	Dr. Sticker, of the German Plague Commission, had at post mortems made during the second week in March 1898 several times cut or otherwise wounded his left hand without any evil consequences. On March 26th he performed three post mortems, and one at 3 p.m. on March 29th, without wounding himself. At 6 p.m. on the 29th, on drying his hands after a bath, he noticed over the metacarpo pharyngeal articulation of the right thumb a small slightly painful vesicle. This received a blow the same evening and the arm at once became painful and plague developed, the bacilli of plague being recovered afterwards from the vesicle. It is not quite clear when the patient inoculated himself, though it is probable that the incubation period was three days.	3 days (?)	
6	Leumann	4542–55	On the 21st of December 1897, about 5 p.m., Captain Leumann, I.M.S., scratched himself at a post mortem. On the 24th December he had a feeling of malaise all day; in the evening he suffered from a sort of mental aberration; he got fever and an enlargement of glands in the armpit on the same side as the scratch and then went through a slight attack of plague.	3 days.	
7	Cook	6496, 6502	On Thursday, October 7th, 1897, Major Giffard, I.M.S., made at Poona a post mortem on an imported case. He had on his wrist a partly healed scar from a boil. He began to feel unwell on Sunday, October 10th, took to bed on Monday, developed an axillary bubo, and went through a typical attack of plague.	3 days.	
8	Cook	6503–6	A Dome who assisted Major Giffard in the post mortem last mentioned died of plague, the bacillus being cultivated from material obtained from an axillary bubo from which he suffered. The patient was not medically attended before his death; his relatives said he was taken ill three days after the post mortem.	3 days.	
9	Evans	6921 (*also* Abstract of Evidence not reprinted with the Proceedings of the Commission).	A Dome contracting plague 48 hours after assisting at a post mortem: an unprotected abrasion of one of his fingers may have been the point of entry of infection.	48 hours.	

Serial Number.	Authority.	Reference.	History of Case.	Length of Incubation as deduced from History.	Remarks.
10	Childe -	1411	A student in the Jamsetjee Hospital, Bombay, pricked himself in the left thumb while assisting in the post mortem of a case of plague. The prick was so slight that he did not notice it at the time. About three days afterwards he developed a bubo in the left axilla, and he subsequently died of plague.	3 days.	
11	Green -	6804 (7220 D. 28).	A man who assisted at a plague post mortem on 3rd June 1898, and who is said to have injured his hand, is reported to have developed plague on 6th. He died on the 10th, two days after he was seen by Major Green, I.M.S.	3 days.	
12	Hutchins -	"Lancet," December 1, 1900.	A warder at Brisbane assisted, on the 8th of October 1900, at two post-mortem examinations of patients subsequently proved to have died of plague. He sickened on the 11th of October, and on the 12th it was shown by clinical and bacteriological examination that the man was suffering from plague. He had abrasions of the hands and axillary buboes.	3 days.	
13	Pinching -	Report on Plague in Egypt from May 1899 to June 1900, p. 45.	Patient, a post-mortem porter, in sewing up a plague corpse, on the 29th of May, contracted an abrasion on the little finger of his left hand from the friction of the string used as a ligature. On the 3rd of June he sickened, and developed plague with an axillary bubo.	3 days.	
14	Leumann -	4567	A Compounder at Hubli was bitten on the thumb by a pneumonic patient, and fell ill 3½ days or 4 days after; he developed a bubo in the axilla and had a mild attack of plague.	3½ to 4 days.	
15	Jennings, reported by Clemow.	7313–5	Sputum was accidentally coughed into the eye of a nurse in Parel Hospital, Bombay, on the 15th of February 1897. Her temperature rose on the 18th. On the 19th, plague symptoms were marked, a bubo developing under the ear on the side of the infected eye.	3 days.	

Class I., Group B.

Group B.—Cases where there is a History of the Patient having come specially into contact with Infection on a Particular Occasion.

Serial Number.	Authority.	Reference.	History of Case.	Length of Incubation as deduced from History.	Remarks.
16	Silcock -	13,814	After the evacuated population of Trimbak had been perfectly free from plague for some time, two cases suddenly occurred in camp. The patients had the previous evening gone into an infected temple to get grain.	1 day.	
17	Steen -	22,732	Three cases of plague occurred at Andumbar among the evicted population within 48 hours of their having been allowed to revisit their houses in connexion with their disinfection.	48 hours or less.	

Serial Number.	Authority.	Reference.	History of Case.	Length of Incubation as deduced from History.	Remarks.
18	Hutcheson -	6006–11, 6024.	The evicted population of Hinganghat (among whom only one attack occurred during the six days following the 26th of November 1898) were, on the 29th of November, allowed to revisit their shops. In direct association with this, six new cases of plague occurred on 2nd December.	4 days.	
19	Winter -	9226	Two men developed plague three or four days after they had gone into the town of Jawalapur to see to the disinfection of their houses.	3 or 4 days.	
20	Katrak -	17,926	A woman took up a rat, found dead, and threw it away; she then scrubbed the floor with plain water. In six or eight hours she felt a sense of chilliness and plague developed.	8 hours.	
21	Bhalchandra Krishna.	19,023	A Parsee lady developed plague 24 hours after she had, while taking out rice, come in contact with a dead rat.	1 day.	
22	McCloghry	11,418	A fitter in Karachi developed plague three days after he handled a dead rat.	3 days.	
23	Dimmock -	20,418	A Goanese servant removed a dead rat from the floor and burnt it. Four days afterwards an attack of plague developed.	4 days.	
24	Da Cunha -	16,513	A woman in Daman, on re-entering her vacated house, trod on a dead rat and developed plague the same evening.	12 hours.	
25	Bhalchandra Krishna.	19,038	A man who assisted in carrying a plague corpse got plague four days after.	4 days.	
26	Justice -	6835–9, 7350, 7394.	Lakhi Some, who, on 1st September 1898, visited Tarak, who was suffering from pneumonic plague, contracted the disease on the 6th.	5 days	These three cases were cases of pneumonic plague which occurred during the epidemic at Backergunge, described in detail elsewhere in this report (para. 203 below).
27	„ -	„	Nukta, who visited Lakhi Some on the 8th September, fell ill with pneumonic plague on the 13th.	5 days	
28	„ -	„	Ramnidhi, who assisted at the cremation of Lakhi Some on 9th September, developed the disease on the 14th.	5 days	
29	McConaghy	12,883–8	A European newspaper editor, who lived in an uninfected part of Poona, and had not otherwise come in contact with plague, developed plague within 24 hours of his having gone round with a search party visiting plague-infected houses.	1 day.	
30	Wilkinson -	10,588–91	A Compounder, who was attacked with plague on May 4th, was probably infected on the previous evening by a visit to an infected house.	1 day	It was elicited that this man was engaged on disinfection work.
31	MacCartie quoted by Bombay Plague Research Committee.	I. 379	A fireman from the steamship *Hydaspes*, which arrived in Bombay on the 7th of January 1897, sickened with plague, with bubo in the groin, on the 9th of January. The ship had come from an uninfected part, and the patient had visited Bombay on the morning of the 8th, and possibly also on the evening of the 7th of January.	1 or 1½ days.	

Inferences derived from consideration of cases detailed in Class I.

It will be seen, on consideration of the histories enumerated in the first of the two tables given above, that in the 15 cases enumerated under Group A., the period of incubation was in only one case as long as five days, in another case it may have been as long as four days, while it was in three cases little, if at all, longer than 24 hours. The average duration of the incubation period of plague works out for the whole of the cases in Group A as under three days. A practically similar result is obtained from a consideration of the cases enumerated in Group B. It will be seen that here also there is in six or seven of the cases a history of plague supervening in as short a period as 24 hours after exposure to infection. The longest period of incubation recorded is a period of five days, and again the average duration of the incubation period works out as under three days.

Indications regarding incubation period derived from (1) history of Chak Kalal. (Serial number, 32) 10,109–10; 10,603. Para. 632 of this Report. 10,189. 10,110.

192 Perhaps more important than any of the data set forth under Group B. are the data relative to the outbreak of the epidemic in Chak Kalal, a village in the Punjab. The inhabitants of this village were, as will be more fully recorded elsewhere, evacuated as a measure of precaution before any plague had come among them. On a particular date they were driven in by a storm of rain, and they took temporary shelter in their houses, in which the bodies of numerous rats dead of plague were found. When after this the people moved out again into camp, 29 cases of plague occurred among them. The sequence of attacks was as follows:—

	Attacks.
On the first day subsequent to the day on which the people took shelter in their plague infected houses -	0
On the second day - - - - -	3
On the third day - - - - -	7
On the fourth day - - - - -	7
On the fifth day - - - - -	1
On the sixth day - - - - -	2
On the seventh day - - - - -	2
On the eighth day - - - - -	0
On the ninth day - - - - -	3
On the tenth day - - - - -	2
On the eleventh day - - - - -	2

There were no further cases.

It will be seen that here the earliest cases occurred after an incubation period of 48 hours, and that the largest number of cases occurred on the third and fourth days. We thus have once more evidence that the incubation period of plague is rarely longer than four days, and in most cases is less than four days. The dropping cases which occurred from the fifth to the eleventh day, while they may possibly be instances of prolonged incubation, may also (as Captain James, who has placed these facts on record, recognises) quite well be due to infection contracted in camp. 10,191–3.

(2.) history of Mahlgahla. (Serial number, 33.) 10,348.

Similar to the case of Chak Kalal in all respects, except only in the fact that the period of exposure to infection here lasted for a full month, is the case of the village of Mahlgahla, also in the Punjab. After evacuation the disinfection of this village began on the 22nd of March 1898. Until the 28th of March work was confined to a particular part of the village, and no cases occurred among the disinfectors employed in this part of the village. On the 28th of March was commenced the disinfection of a part of the village where large numbers of dead rats were found. On the 2nd of April cases began to occur among the disinfectors, these not having come in contact with any plague patients. The disease spread to such an extent that work was stopped on the 22nd of April. On the 23rd of April there were 13 cases among the disinfectors; on the 24th, two cases; on the 25th, three cases; on the 26th, two cases; and on the 27th of April, one case. The epidemic then died out. This history brings out two points; first, that the disease developed five days after the disinfectors first came into contact with infection; and secondly, that the last case of the disease developed five days after exposure to infection ceased.

Class II.

193. We pass now to set forth and consider the cases which we have collected under Class II.

CLASS II.

CASES in which there is a HISTORY of the PATIENT having been in CONTACT with INFECTION on and after a PARTICULAR DAY.

Serial Number.	Authority.	Reference.	History of Case.	Length of Incubation, as deduced from History, may have been less than, but cannot have exceeded	Remarks.
34	Illingworth	4481	A girl developed plague in a village near Guntakal 24 hours after the infection had been imported into that village by her father.	1 day.	
35	Hossack -	7576	A nurse at Poona contracted the disease in the pneumonic form when she had been "perhaps two or three days" in attendance on a case of pneumonic plague.	3 days.	
36	Bombay Plague Research Committee.	I. 379	On the 4th of January 1897, Nurse Joyce went to attend Major Manser, I.M.S., who was suffering from plague pneumonia. She nursed him from the 4th till the morning of the 6th. She was attacked by plague pneumonia on the evening of the 7th.	3 days.	
37	Anderson -	23,207	In Kersova a case was imported on 30th, proving fatal on the 31st of January 1897. The schoolmaster, who lived in the Talati's house, visited the patient, and on the 2nd of February the Talati's nephew sickened.	4 days.	
38	" -	"	In Kelwa, five days after the arrival from Bombay of people who stayed three days, plague broke out among men, rats having died in the interval.	Under 5 days.	
39	Niblock -	12,446	Two servants, belonging to Banniahs in Sharafi and Reri, went to the Joria Bazar at Karachi on the 16th of May 1898, and returned on the 19th; one developed plague on the 21st in Reri; and the other on the 23rd in Sharafi; four of their masters, probably infected by them, developed plague on the 24th of May.	5 days. 7 days. 5 days.	
40	Dhurandhar	15,202	People from Bombay stopped three days in Ahmedabad; three days after they left, plague occurred among the people with whom they had stayed.	6 days.	
41	Justice -	6835–9, 7350–94.	Girija and Upendra, who had been exposed to the infection of pneumonic plague from the 27th to the 31st of August 1898, were attacked on the 1st of September.	6 days.	This and the subsequent cases reported by Dr. Justice are all cases of pneumonic plague which occurred in connexion with the epidemic at Backergunge, described in detail (para. 203 below).
42	" -	"	Tarak, who had been similarly exposed, developed the disease on the 2nd of September.	7 days.	
43	" -	"	Girija's wife, who nursed her husband, who had sickened on September 1st, developed the disease on the 9th.	9 days.	
44	" -	"	Baikuntha, who nursed Lakhi Some from the 6th to the 9th of September, fell ill on the 14th.	8 days.	
45	" -	"	Ramani, who also nursed Lakhi Some between the dates in question, developed the disease on the 13th of September.	7 days.	
46	" -	"	Kamini, who nursed Baikuntha from the 13th to the 17th of September, fell ill on the 20th.	8 days.	
47	" -	"	Harsundari nursed Ramnidhi from the 14th to the 16th of September, and fell ill with pneumonic plague on the 20th.	7 days.	

Serial Number.	Authority.	Reference.	History of Case.	Length of Incubation, as deduced from History, may have been less than, but cannot have exceeded	Remarks.
48	Dyson -	6716–20	The Compounder who attended Bishnadutt, who died of pneumonic plague at Chausa on 31st August, was taken ill three days after he saw the patient.	3 days	The history of this case is not altogether clear.
49	Hutcheson -	5958	A boy at Khandwa, who probably came in contact both with an imported case of plague on the 29th of October 1898, and with dead rats which were found in the house on the 30th and 31st of October, was attacked by plague on the 2nd of November.	5 days.	
50	Anderson -	23,207	A girl was attacked by plague in Jegapur three days after dead rats had been found in the house, and five or six days after her father returned from Dharwar, which was then infected with plague.	6 days.	
51	" -	"	Plague broke out at Santa Cruz, three days after dead rats were found.	3 days.	
52	" -	"	Plague broke out at New Kurla, four days after dead rats were found.	4 days.	
53	" -	23,210	Plague broke out at Pali six or seven days after dead rats were found.	6 or 7 days.	
54	McCloghry	114,224	A woman in Karachi, living at a distance from any infected quarter, developed plague four or five days after dead mice were found in her house, no other source of infection being traceable.	5 days.	
55	Anderson -	23,210	Three days after the people of Joo returned to their houses, which were evacuated owing to dead rats being found, plague appeared among them.	3 days.	
56	Hay - -	22,223	In Areh dead rats were found on the 1st and 2nd of October 1898, in two houses; on the 3rd of October nine cases of plague occurred in both houses and in the adjoining houses.	2 days.	
57	Petigara -	14,363	On the fourth day after dead rats were found in the Karad Post Office, the Postmaster's daughter was attacked.	4 days.	
58	Hay - -	22,223	In Bhiwandi plague broke out in a house seven days after dead rats were found there.	7 days.	
59	Weir -	1180	On the 29th of November 1897, an old woman got plague in Bombay. Rats had been found in her house on the 19th of November and again on the 24th. On the former occasion the old woman is said to have thrown out the dead bodies.	10 days.	
60	Gcdinho -	17,996	Eight days after a listless rat was found on the 5th March 1898, a servant boy, who is said to have killed and burnt a rat, was attacked with plague.	8 days.	
61	Hyde-Cates	13,456	After the evacuated population of Bada had been free from plague for 17 days, they were, on the occurrence of rain, allowed into their houses for four days. Immediately after they came out again into camp four cases of plague occurred among them.	4 days.	
62	Steen -	22,737	After evacuation had stopped the plague in Pademal, people were, on the 29th of June, allowed to re-visit their houses for disinfection, and on the 4th of July cases began again.	6 days.	

Serial Number.	Authority.	Reference.	History of Case.	Length of Incubation, as deduced from History may have been less than, but cannot have exceeded	Remarks.
63	Giles -	11,271	A disinfected family that re-occupied a disinfected house had four cases of plague (including one death) within five days of re-occupation.	5 days.	
64	" -	11,266	An infected room was left vacant till the 15th of April 1898. A man then went to live in it and got plague on the 18th; and later on, on the 14th of May, another man, who had used the place for cooking for two or three days only, got plague there.	3 days. 2 or 3 days.	
65	" -	11,276	A Prostitute who, about the 23rd of April 1898, re-occupied a disinfected house, developed plague four days later.	4 days.	
66	" -	"	On the 20th of April 1898, a disinfected and vacated house was re-occupied; plague occurred there again on 24th.	4 days.	
67	Niblock -	12,380	A Policeman died of pneumonic plague in the lines at Karachi on the 18th of April 1898. On the 26th of April, a second Policeman, who had wounded his right foot at noon, was admitted to hospital at night. He developed plague next morning, bubo developing on the right side. It was supposed that the infection was contracted through the wound on the foot.	24 hours.	
68	" -	12,387	A phthisical patient, who had been in the Civil Hospital, Karachi, since the 12th of January, suddenly developed plague on the 6th of February. It was supposed that he had contracted the infection from a a case admitted on the 1st of February, that case having developed buboes and died on the 4th.	5 days.	
69	Cornwall -	4316-9, 4323-5.	A patient came to hospital and was there two days till he died. A friend came from an uninfected place and nursed him from the time of his admission. She and her clothes were disinfected when his death occurred. She fell ill of plague three days after the death.	5 days.	
70	—	—	Dr. Müller, a Member of the Austrian Plague Commission, who was in attendance from the 15th to the 18th October 1898, on a laboratory servant, Barisch, suffering from plague pneumonia, fell ill of plague pneumonia on the evening of the 20th of October. The case occurred at Vienna, where there was no other case of plague at the time, the first patient having contracted the disease in the laboratory.	5 days.	
71	—	—	Nurse Pecha, who attended the servant above mentioned, was also taken ill on the 20th October, after having been in contact with the patient for five days.	5 days.	

Inferences derived from consideration of cases in Class II.

194. We may most conveniently deal with the evidence collected together in the above table if we ask ourselves how far it supplies us with data for answering, first the question as to what is the shortest incubation period; secondly, as to what is the average length; and, thirdly, as to what is the extreme length of the incubation period in plague.

Para. 367 of this Report.

In connexion with the first question, it will not be necessary to do more than point out that three of the histories incorporated in the present table seem to afford confirmation of the fact, already established above, that plague may develop possibly within 24, and certainly within 48, hours after exposure to infection. Similar instances of incubation periods, not exceeding 24 hours, are, we may note, recorded in connexion with mahamari in Kumaun.

In connexion with the question of the average duration of the incubation period, a reference to the fifth column of the table will show that in a majority of cases, even counting in the time which must in many cases have intervened between first exposure to the infection and the contraction of the illness, the incubation period works out as shorter than five complete days. This, however, does not definitely resolve the question as to the average duration of the incubation period in plague, for manifestly cases of short incubation are more likely to arrest attention and therefore to be brought upon the record, to the exclusion of cases in which the period of incubation was longer. It is impossible to be sure that this source of fallacy has been entirely excluded, but we think that, even making allowance for it, it cannot have operated so as to falsify the record to any considerable degree. In confirmation of this opinion, we would point to the epidemic at Backergunge, which has supplied us with a considerable number of cases for fixing the duration of the incubation period. Here all the cases without exception have been brought upon the record, and there is among them no single instance of any long incubation period. This remark applies also to the cases which occurred among the disinfectors at Mahlgahla, subsequent to the suspension of the disinfection operations here, as we have seen, no case developed more than five days after exposure to infection ceased. And we would in particular, in this connexion, lay stress upon the circumstance that we constantly found that plague officers in India were unconsciously biased by the dictum of the Congress of Venice, which fixed the duration of the incubation period of plague for quarantine purposes at 10 days. We think that, under the influence of the unconscious bias just referred to, there would naturally be a tendency on the part of many plague officers, on the one hand, to notice and to record cases where the incubation period corresponded with the 10 day period of the Congress of Venice, and, on the other hand, to omit from recording, as in probability fallacious, cases which seemed to point to a shorter incubation period. We therefore think that the extreme limit of the period of incubation in an average case of plague probably lies well within the limit of five days, which is arrived at by a consideration of the cases collected in the table above.

Lastly, as to the question of the extreme limit to which the period of incubation may in exceptional cases be prolonged, it will be unnecessary at the present moment to say more than that data for determining this question cannot possibly be afforded by cases such as those now under consideration, where the patient has lived continuously in the presence of infection. Thus, for instance, it is manifest that the fact that periods of 8 and 10 days supervened in certain of the cases here recorded between the *first* exposure to infection and the invasion stage of the disease cannot be regarded as evidence that the incubation extended over the whole of the periods in question.

Class III.

195. We may pass from this to a consideration of the cases coming under Class III.

CLASS III.

CASES where PERSONS were REMOVED from INFECTED SURROUNDINGS into EVACUATION and SEGREGATION CAMPS.

Reference.	Place.	Total Cases in Camp.	Number of Plague Attacks on successive Days after Arrival in Camp.											Remarks.
			1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	After 10.	
20,442	Bombay - - -	146	46	35	19	16	11	10	7	1	—	1	2	
17,367	(Wari Bandar. Mr. Shikari's Camp.)	166	52	35	20	21	12	14	7	1	—	1	3	Total in evidence, 167 wrong.
	Poona:—													
21,835	(1st and 2nd epidemic	146	21	20	17	22	22	15	7	6	8	2	6	
25,827	3rd epidemic to March)	14	2	3	3	4	1	1	—	–	—	—	—	
14,182 1,291	Anand - - -	78	32	1	17	9	7	1	6	2	1	1	1	
25,030	Civil and Military Station, Bangalore.	75	26	16	5	5	8	1	3	1	7	3	—	
1,926	Dharwar - -	50	5	11	8	6	5	1	1	4	1	7	1	
23,693	Gadag - -	34	1	6	5	6	10	2	2	1	1	—	—	
1,291	Bhusawal - ·	26	25	—	1	—	—	—	—	—	—	—	—	
14,215	Ankleshwar - - -	8	—	1	—	—	4	—	1	—	—	—	2	
13,722	Porbandar - -	5	—	—	1	—	2	1	1	—	—	—	—	
- -	Total - -	753	210	128	96	89	82	46	35	15	18	15	15	

Inferences derived from a consideration of figures tabulated in Class III.

The question as to whether we can learn anything from cases in Class III., as to the shortest duration of the incubation period, can be immediately answered in the negative, when in the light of the information already obtained, we consider the fact that nearly half (338 out of the total of 753) cases recorded in the table occurred on the first two days after admission to camp. It is obvious from this fact that a large proportion of the total patients attacked cannot have been removed to camp until they were in a somewhat advanced stage of their incubation. All deductions as to the minimum duration stage of plague drawn from the figures above would thus be grossly fallacious.

On the question as to the average duration of the incubation period of plague, the figures in the table are of somewhat greater value. It would seem probable, from the fact that the number of attacks in camp drops from 82 to 46 on the sixth day in camp, that the influence of removal from plague infected dwellings to camp made itself felt on that day. It is suggestive that the period after which the marked decline in cases begins corresponds in an approximate manner with the period of incubation as fixed on the basis of the trustworthy evidence considered above.

Lastly, with regard to the question of the extreme limit of the incubation period, it would, indeed, on first approaching such a table as that given above, seem justifiable to hope that it would afford for the determination of this important question data even more valuable than those afforded by consideration of the cases we have collected under Class I. This hope is, however, not justified: for as we shall see in a subsequent section of this Report, where we consider the question of segregation camps, there was, in most of the segregation and evacuation camps, unavoidably some opportunity for a moderate spread of infection in camp. Thus the cases occurring on the later days in camp may quite well have originated from infection contracted after admission to camp, and they cannot be adduced as evidence of the occurrence of plague after a prolonged incubation period.

Sections III. (2) and IV. (3) of Chapter VI. of this Report.

Criticism of cases alleged to have had exceptionally long incubation periods. 22,414, 22,475.

196. The same canons of criticism apply to the isolated statements of witnesses to the effect that they had, in their experience of segregation camps, obtained evidence that the incubation period might be very prolonged. The statement of Captain Thompson, I.M.S., that he had met with a number of cases in segregation camp which pointed to an incubation period of over 10 days, may readily be explained by reference to the possibility of the infection of these cases having been contracted in camp. The possibility of such infection was, indeed, admitted by Captain Thompson himself. Mr. Cappel's statement, that he had seen contacts in camp develop plague 18 days after they had been received into camp, is probably capable of a similar explanation. The only other specific cases which have been reported to us with a view to proving the existence of an incubation period of more than 10 days, are the cases brought forward by Major Evans, I.M.S., by Mr. R. N. Jadhav, and by Colonel McConaghy,

1904.

6888. I.M.S. and Mr. Bharucha. The case reported by Major Evans was that of a medical
student, who developed plague 14 days after he had assisted at the post-mortem of a
plague case ; it, however, is not certain that the infection was contracted at the post-
mortem in question, as the patient had in the interval been engaged in bacteriological
15,187. work in a laboratory where investigations on plague were being conducted. In the
particular case adduced by Mr. Jadhav, a native groom is recorded to have developed
12,889-92. plague five weeks after he had come from Bombay to Baroda. In the case reported
21,658-63. by Colonel McConaghy and Mr. Bharucha, a Parsee child is said to have developed
plague 14 days after it had arrived in Poona from Bombay. It will be obvious that
in the two last cases infection may have been carried from Bombay in personal effects,
and in the particular case of the Parsee child there is the further possibility that
infection may have been contracted in Poona, since suspicious cases were apparently
occurring in Poona, in and about the time when the child contracted the disease.

Conclusion that no case on record where a longer incubation period than five days has been established; qualification with regard to cases of pestis minor if such develop into typical plague.

197. While thus no facts have been reported to us which establish that the incubation period may be prolonged beyond the period of five days, the limit fixed by the consideration of the numerous cases detailed above under Class I., we think that it is a matter of importance to point out that where the plague first takes the form of pestis minor, and where afterwards that pestis minor develops, owing to some subsequent loss of resisting power, into typical bubonic plague, there is a possibility of a considerable interval elapsing between the time at which the infection was contracted and the time at which the clinical symptoms become typical. Such cases, important as they are in the epidemiological study of the disease, as indicating one of the possible but quite exceptional ways in which plague may be carried about to distant countries over sea, are, it must be observed, of extremely rare occurrence. One such case has, however, come unofficially to our knowledge in Poona.

VI.—EPIDEMIOLOGICAL AND BACTERIOLOGICAL DATA REGARDING THE INFECTIVITY OF PLAGUE.

Infectivity of plague.

198. We propose now to deal with the question as to how far plague-infected persons and animals are directly infective, and as to how far the infection derived from infected persons and animals is harboured in the houses which have been inhabited or frequented by, and in objects which have been in contact with, such persons and animals.

VI.(1).—*Infectivity of Plague Patients taken generally.*

Data pointing to the slight infectivity of plague patients considered generally.

199. It will be convenient to postpone the consideration of differences in the infectivity of each of the different clinical types of plague taken separately until we have formed an estimate of the degree of danger incurred in coming into contact with plague patients taken generally. We are enabled to form such an estimate by availing ourselves of the data furnished to us with regard to the communication of the disease in hospitals to the staff and friends in attendance on the sick.

We are told, with regard to the principal Plague Hospital in Bombay—the Arthur
Road Hospital—that of the large staff, not only of regular hospital attendants but also
20,989, 20,975. of relatives in attendance on the sick, only seven contracted plague. One of these was
a relative in attendance. The remaining six were members of the hospital staff, who,
according to Dr. Choksy, the physician in charge, lived in plague-infected houses outside
the precincts of the hospital. If Dr. Choksy is correct in this, it would follow that in
the case of this hospital, where nearly 4,000 plague cases were treated between
September 1896 and February 1899, the disease could not in any single instance be
brought home to infection from a patient.

We find from statements published in General Gatacre's Report on the Plague in Bombay that in the Grant Road Hospital, from the 4th March to 15th June 1897, there were no cases of plague among the 400 friends who either visited the patients or remained constantly at their bedsides. One attendant, however, contracted the disease. In the same hospital, it appears from statements published in Sir James Campbell's Report on plague in Bombay, there were in the last five months of 1897 and the first three of 1898, only two cases of plague among the relatives in attendance on 2,109 patients; among the staff of the hospital there were five cases.

Captain G. S. Thompson, I.M.S., summarized his experience gained in the Parel
22,489. Plague Hospital at Bombay in the following statement :—" In upwards of 240 instances
the friends of the patients attended their sick, ... and in not a single

instance did the disease spread to the friends. Out of more than 140 attendants on the sick belonging to the hospital staff from time to time, only one sweeper was attacked, and he had been constantly helping in the post-mortem room, and had a very mild attack with small axillary bubo." Captain Thompson placed before us information which he had collected also with reference to five other smaller plague hospitals in Bombay. In these five hospitals there were in the aggregate 104 attendants, of whom only two contracted plague. In both these cases, it was believed that the disease was not contracted in hospital.

Major Deane, R.A.M.C., who had experience of Bombay hospitals, observed the 2789.
absence of cases of infection among the staff and the attendants.

In Poona, at the General Plague Hospital, during the period covering the last six 21,539, 12,876.
months of 1897 and the first three of 1898, no cases of infection came to notice among a total of 4,138 relatives in attendance on the sick; 26 cases occurred among the hospital staff, numbering 376. In the Hindu Hospital at Poona, during $2\frac{1}{2}$ months beginning on the 15th March 1897, there were 2 cases among 104 persons who came to attend the sick: again, during six months in the second epidemic, 2 cases occurred among 533 friends who visited the sick, while 2 additional cases occurred among the members of the hospital staff, who numbered 57.

In the Hubli Hospital, only two cases of infection among the actual hospital 1704.
attendants, who were on duty both night and day, came to the notice of Mr. Cappel.

In the Dharwar Hospital, where 740 patients had been treated up to the beginning 1851.
of December 1898, there had at that date been six cases of plague among 31 hospital 1900, 1854.
attendants, and 30 or 32 cases among relatives in attendance. These last numbered in 1953.
all about 900. Many of these last may, it was suggested, have been infected before 1684-5.
they came into the hospital. 1896-9.

In the Gadag Hospital, out of the relatives and friends in attendance on the sick, 23,685-8.
whose number has been estimated as approximately 250, three were attacked by plague.
It is stated that these three patients probably contracted the disease outside. Of the 23,689-91.
hospital staff, who numbered 23 persons, none contracted plague. 23,757.

In Bangalore Civil and Military Station, we learn that of 61 attendants employed at 2737, 2922.
different times in the North Camp Hospital, four, up to the beginning of December
1898, contracted plague. In the South Plague Camp, no member of the hospital 2923.
establishment was attacked.

In Cutch Mandvi, Major Hyde-Cates told us that, in 1898, there were eight cases 13,533-5.
among the relatives of the patients, and that there were six cases among the hospital
staff; it does not, however, appear whether in this last figure are included two cases of I. 351.
plague recorded by Captain Mason, R.A.M.C., as having occurred among the hospital staff in 1897.

In Surat, we were told by Lieut.-Col. Nariman, I.M.S., "In the General Plague 15,796.
Hospital, with the exception . . . . of a civil medical pupil, none of the hospital establishment was attacked with plague. Out of about 900 attendants who lived in the hospital to look after their relatives, only 12 were attacked with plague. Of these 8 were attacked almost within 24 hours of admission, 2 within 48 hours, and 1 each on the 10th day and 20th day respectively." The statements made as to the number
of attacks among the staff and attendants and relatives in the Hindu Hospital at Surat 15,824-5.
are conflicting. 16,149.

In Porbandar there were two cases among the hospital staff and relatives in 13,742.
attendance on 465 cases of plague. II. 484.

In the Sirohi State there were eight attacks of plague among persons who attended 9906.
on 140 patients, each patient being allowed one attendant.

In none of the hospitals in Calcutta did any spread of infection in hospital come to 7020; 7081.
notice.

Neither in Umreth nor in Broach was there any spread of infection in hospital. II. 233, 15,500.

Inferences derived from consideration of above statistics.

200. In spite of the fact that it is quite probable that all cases of plague occurring among the attendants on the sick in hospitals were not brought on to the record, the above figures show clearly that the danger of direct infection from plague patients is very small, under conditions such as those of hospitals in India, where attention is paid to the proper ventilation and cleanliness of the buildings, where the floors are, in a considerable number of the hospitals, periodically treated with disinfectants, and where precautions, such as the wearing of shoes are, as far as possible, insisted on. It must further be noted, as enforcing what has been said above with regard to the smallness of the risk that is incurred by direct contact with the sick, that in the hospitals under consideration personal disinfection was entirely neglected by the large majority of the staff, and that the

relatives attending on the sick rarely took even the most elementary precautions against infection. Not only did these last remain night and day with the patients, but they, in many cases, ate and drank out of the same vessels with them—not to speak of the fact that they, in some instances, received the sputum of the sick with their hands.

Confirmation of above inferences by experience of plague officers.

1439; 1516. 201. We may further, in connexion with the risk of direct infection from the plague patient, quote the conclusions arrived at by medical officers and others whose experience entitles them to speak on the question. Captain Childe, I.M.S., basing his opinion on the fact that the many unrecognised cases of plague, which had at the beginning of the outbreak in Bombay been admitted into the general hospitals, had not led to any spread of the infection, was of opinion that "in a well ventilated house or
10,374–5, hospital the infectiousness is very slight indeed." On their experience in the Punjab
10,488. that infection does not spread from cases treated in hospital, Captain James, I.M.S., and Captain Wilkinson, I.M.S., formed an opinion similar to that of Captain Childe.
1165. Lieut.-Col. Weir, I.M.S., Medical Officer of Health of Bombay City, expressed the
18,146. opinion that plague is not very infectious from person to person. Lieut.-Colonel Henderson, I.M.S., thought that "the person to person infection is very rare indeed."
12,876. Lieut.-Colonel McConaghy, I.M.S., thought that plague was not very infectious.
17,722. Dr. Blaney's experience was that there is very little conveyance of infection from one person to another. This was also the experience of most of the witnesses who
7243; 18,789; expressed an opinion on the subject—we may refer to the evidence of Dr. Clemow,
22,554; 25,229. Mr. Shepherd, Mr. Ghanekar, and Khan Bahadur Bomanji Biramji Patel.

VI.(2)(a).—*Epidemiological Facts bearing upon the Infectivity of Pneumonic Plague.*

Infectivity of clinical forms separately considered. Primary pneumonic plague—epidemiological and clinical evidence; very infectious, disease tending to reproduce itself in same clinical form.

202. In particular cases, however, a high degree of direct infectivity has been noticed; the cases in point appear in almost every instance to have been cases of primary pneumonic plague.

In the village of Gangaur, in the Baroda State, 37 fatal cases of plague originated from a case which was, from the history, inferred to be a case of pneumonic plague. Of these 37 cases, 13 occurred among the relatives of the man who was first attacked. Most of the other cases occurred among the friends who attended the funeral.

At Muska, in the Cutch State, a woman who, from the symptoms described, appears to have been suffering from pneumonic plague, communicated the disease to her sister,
15,182–5. who attended upon her. This sister on her return to her village infected 10 other
530, 13,366. members of the family.

18,213. Mr. Shroff, a Deputy Health Officer of Bombay City, instanced the case of a lady who suffered from pneumonic plague and who communicated the same form of plague
18,209–12. to two persons who came into contact with her. He also told us of a case of pneumonic plague in a Hospital Assistant which gave origin to 10 further cases of pneumonic plague, three or four of these subsequent cases occurring among persons who attended the funeral of the original patient.

17,990–1. Mr. Godinho, also a Deputy Health Officer of Bombay City, cited the case of pneumonic plague occurring in a Resident Surgeon in the Mahratta Hospital, Bombay, which gave origin to eight further fatal cases of plague.

Annales de l'Institut Pasteur, Oct. 1898, p. 681. Dr. Simond cites the case of a sepoy at Karachi who died of plague pneumonia. Of 12 of his comrades who visited him when moribund and attended his funeral, seven developed plague within three days of the funeral.

12,997–8. At Manora a case of pneumonic plague in a Muhammadan gave origin to four further cases among the co-inhabitants of the house. One of these cases was of the bubonic form and three were cases of pneumonic plague.

15,454–8. At Baroda four cases of pneumonic plague were observed by Major Sarkies, I.M.S.; these all occurred quickly one after the other, and were due to infection conveyed from one to the other.

1891–2. In the Dharwar Hospital four of the six attendants who were attacked suffered from pneumonic plague, and from the evidence of Dr. Hornabrook it would appear probable that they contracted the disease from patients who had the pneumonic form of plague.

9523–33. A case of pneumonic plague, which occurred at Kankhal, gave rise to three further cases, all these occurring in the same family. These were the only cases of pneumonic plague which came under observation at Kankhal.

9533–5. A case of pneumonic plague, which occurred at Jawalapur, was traced to infection contracted from a pneumonic patient.

18,509. Mr. Britto cited a case of pneumonic plague from which two persons were infected, one of these being an attendant on the sick person.

Major Manser, I.M.S. contracted plague in the pneumonic form. The infection spread from him to the European nurse who was in attendance upon him. The nurse contracted the disease also in the pneumonic form. 1439.

Another example of the same sequence of events was furnished by the series of plague cases that occurred in Vienna. Here a laboratory attendant, Barisch, contracted the pneumonic form of plague. The infection then spread to his medical attendant and to a nurse. Dr. Müller and Nurse Pecha, the doctor and the nurse in question, both contracted the disease in its pneumonic form. 7220 (17), (22), and (58).

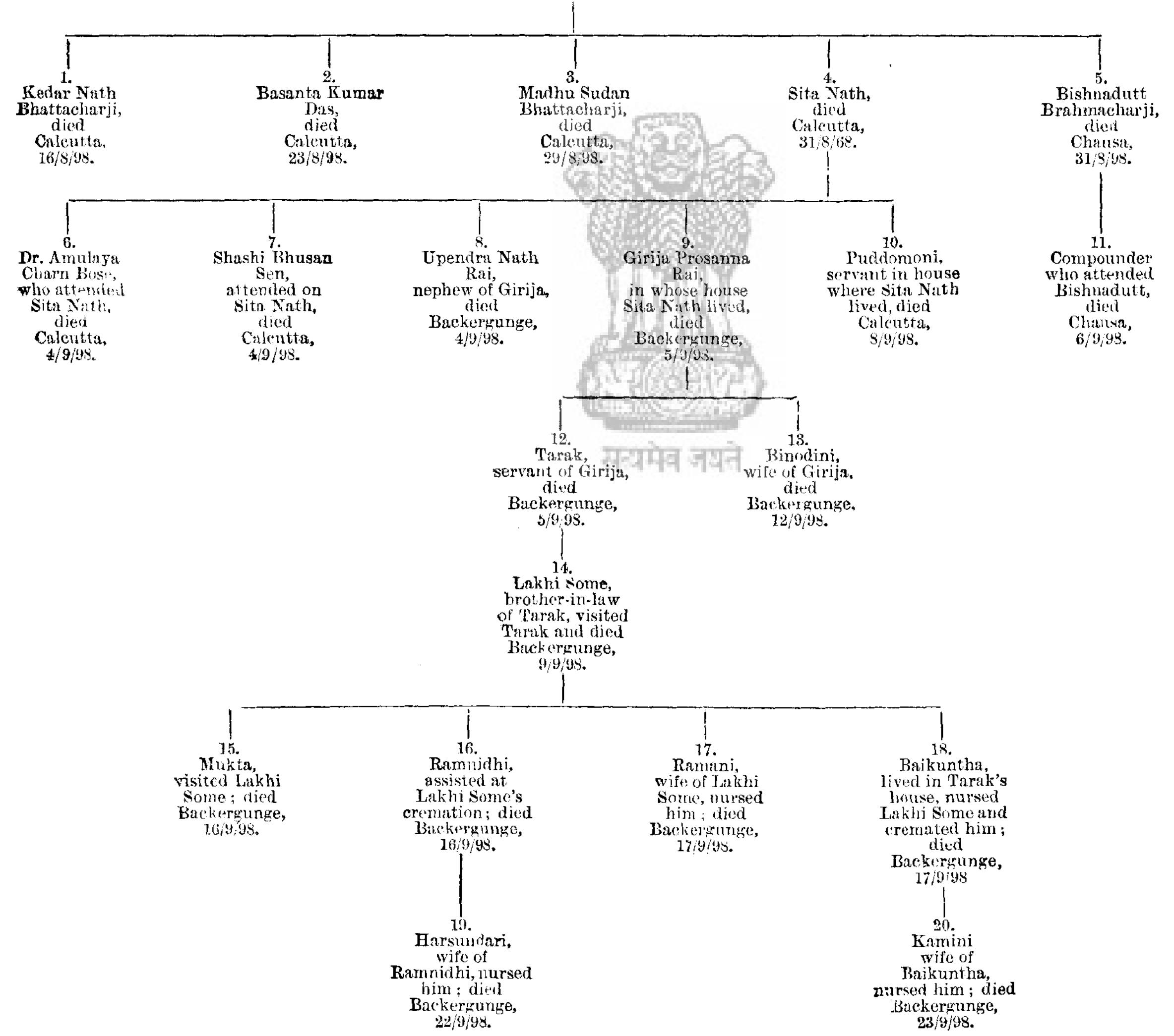
A nurse in Poona contracted plague in the pneumonic form two or three days after she had come into attendance on a patient suffering from this form of the disease. 7576.

In Calcutta, a case came under observation in which a person in attendance upon a patient suffering from plague pneumonia contracted the disease in the same form. 7515.

The above instances bring out with clearness the infective nature of pneumonic plague, and the risk that is run by those who are in attendance or contact with cases of this type. They also very strongly suggest that the infective material derived from a case of pneumonic plague tends to reproduce the disease in the same form. The facts detailed below with regard to an epidemic of plague pneumonia which occurred at Backergunge confirm these conclusions in a very striking manner.

203. The details of this epidemic, which originated in Calcutta in the house of Kaviraj Dwarka Nath, a lecturer on medicine, are given below in the form of a table which we have prepared from the data supplied to us by Major Green, I.M.S., and Dr. Justice :— History of the Backergunge epidemic of plague pneumonia.

ORIGINAL SOURCE OF INFECTION IN THE HOUSE OF KAVIRAJ DWARKA NATH IN CALCUTTA.


1. Kedar Nath Bhattacharji, died Calcutta, 16/8/98.
2. Basanta Kumar Das, died Calcutta, 23/8/98.
3. Madhu Sudan Bhattacharji, died Calcutta, 29/8/98.
4. Sita Nath, died Calcutta, 31/8/68.
5. Bishnadutt Brahmacharji, died Chausa, 31/8/98.
6. Dr. Amulaya Charn Bose, who attended Sita Nath, died Calcutta, 4/9/98.
7. Shashi Bhusan Sen, attended on Sita Nath, died Calcutta, 4/9/98.
8. Upendra Nath Rai, nephew of Girija, died Backergunge, 4/9/98.
9. Girija Prosanna Rai, in whose house Sita Nath lived, died Backergunge, 5/9/98.
10. Puddomoni, servant in house where Sita Nath lived, died Calcutta, 8/9/98.
11. Compounder who attended Bishnadutt, died Chausa, 6/9/98.
12. Tarak, servant of Girija, died Backergunge, 5/9/98.
13. Binodini, wife of Girija, died Backergunge, 12/9/98.
14. Lakhi Some, brother-in-law of Tarak, visited Tarak and died Backergunge, 9/9/98.
15. Mukta, visited Lakhi Some; died Backergunge, 16/9/98.
16. Ramnidhi, assisted at Lakhi Some's cremation; died Backergunge, 16/9/98.
17. Ramani, wife of Lakhi Some, nursed him; died Backergunge, 17/9/98.
18. Baikuntha, lived in Tarak's house, nursed Lakhi Some and cremated him; died Backergunge, 17/9/98
19. Harsundari, wife of Ramnidhi, nursed him; died Backergunge, 22/9/98.
20. Kamini wife of Baikuntha, nursed him; died Backergunge, 23/9/98.

The series of cases, it will be seen, originated in the house of Kaviraj Dwarka Nath, into which the infective material must by some channel or other, which has not been ascertained, have been introduced. Five persons in this house contracted pneumonic plague. Two only of these cases, those of Bishnadutt and Sita Nath, gave origin to further cases. We may deal first with the case of Bishnadutt. This man fled from Calcutta and was seized with symptoms of pneumonic plague at the railway detention camp at Chausa. He died there, after communicating fatal infection to the Com- 6836, *seq.* 7331, *seq.*

pounder who attended him. Sita Nath, whose name appears fourth in our table, was the other patient who was instrumental in the spread of the infection. He communicated the infection to five persons who came into contact with him, and all these persons died of pneumonic plague.

7067. One of these derivative cases (No. 6 in our table) was seen on four occasions by Lieut.-Col. R. C. Sanders, I.M.S., who formed the opinion that the case did not differ from any ordinary case of pneumonia. Lieut.-Col. Sanders based his opinion on the fact that the patient remained rational, and that he did not communicate the infection to any of the numerous persons who visited him. We think this is hardly sufficient ground for concluding that this was not a case of plague pneumonia, for consciousness is in cases of plague pneumonia often preserved to the last, and, fortunately, cases of plague pneumonia do not always give rise to further cases. Again, the patient seems to have been haunted throughout, even when his symptoms were comparatively slight, by a fixed premonition of death, such as has often been noticed in connexion with cases of plague pneumonia.

To return to our table. Only one of the cases derived from that of Sita Nath spread the infection. It will be seen that the man numbered 9 in the table, and placed fourth in the second generation of cases, contracted pneumonic plague and communicated the infection to his wife and to his servant, Tarak. Both of these died of pneumonic plague. The infection passed from Tarak through his brother-in-law, Lakhi Some, who also succumbed to the pneumonic form of the disease, to four persons, all of whom either visited the sick man or attended his cremation. These again all died of pneumonic plague, two of them handing on the infection to their wives, who, in their turn, contracted plague in a pneumonic form, and succumbed.

Thus we have, in all, twenty cases of plague, all of the pnemonic form, and all of which terminated fatally. This observation is, in our opinion, one of unique value. It derives its importance, first, from the fact that even in the absence of bacterio-
7473. logical information (the material which was designed for baeteriological examination accidentally miscarried), the diagnosis of plague is rendered almost certain by the extraordinary fatality of the attacks; secondly, from the fact that in view of the small amount of plague at that time in Calcutta, and of its entire absence from the neighbourhood of Backergunge, the genealogy of each case in the series seems to be securely established; and, lastly, from the illustration which is here afforded of the tendency of pneumonic plague to reproduce pneumonic plague through a series of generations.

Opinions, embodying experience of witnesses, that pneumonic plague eminently infectious.
504.
1439.
9586.
10,201.
4370.
19,201-4.
14,717-9.
17,788.
11,163.

204. If anything more were required to confirm the highly infectious character of pneumonic plague, this would be supplied by the experience of witnesses who have been engaged in plague duties. Thus Lieut.-Col. Wilkins, I.M.S., said that he had many instances in which this type of plague had given rise to other cases. Captain Childe, I.M.S., said: "I think in many circumstances the pneumonic form is highly infectious." Captain Elphick, I.M.S., said: "I think the pneumonic cases are the infectious cases." Captain James, I.M.S., thought that the pneumonic form of plague was highly infectious. Lieut. Cornwall, I.M.S., expressed the opinion that the pneumonic form undoubtedly spreads the disease most. Dr. Freeman Underwood and Dr. Maynard thought pneumonic plague extremely infectious, and noted that pneumonic cases produced cases of the same type. Mr. Ismail Jan Mahomad also said that he had noticed that pneumonic cases gave rise to pneumonic cases. Mr. Giles referred to this type of plague as "known for its spread of infection."

VI.(2)(*b*).—*Bacteriological Facts bearing upon the Infectivity of Pneumonic Plague.*

Bacteriological data bearing on the infectivity of pneumonic plague.

205. The extreme infectivity of the primary pneumonic form of plague might have been concluded from the fact that the bacteria in this form of plague cultivate themselves in the lungs, and are thrown off in enormous quantities in the sputum. Another point with regard to the infectivity of pneumonic plague which has been brought out by bacteriological observation is that the bacteria continue to be thrown
25,334-5. off in the sputum for prolonged periods. Dr. Cyril Cayley has furnished us with particulars with regard to this point relating to 17 out of 43 cases of plague pneumonia
25,342. which he examined:—"As a rule, I found plague bacilli in the sputum for a fortnight after the lung symptoms developed, but there was one case which was 28 days, three
25,346. days after the temperature was normal. . . . . In 13 cases the plague bacilli were found in periods varying from 10 to 14 days, in one case 15 days, in one case 19 days, and in another case 23 days." It would seem probable that many, at least, of the

cases examined by Dr. Cayley were cases of secondary pneumonia. In cases of primary pneumonic plague (and we shall presently see that this holds true also in connexion with secondary pneumonic plague) plague bacilli may be found in the sputum long after convalescence has to all appearance been established. A case of primary plague pneumonia which illustrates this point has been published in detail by Dr. E. Gotschlich. (Zeitschrift für Hygiene, 1899, p. 405.) In the case in question plague bacilli were, by means of inoculation experiments, shown to be present in the sputum for a period of 33 days after the temperature had returned to the normal. When they finally disappeared the patient had long been to all appearances perfectly well, and had been out of bed for 19 days.

VI. (3)(*a*).—*Epidemiological Facts bearing upon the Infectivity of Septicæmic and Bubonic Plague.*

Infectivity of the septicæmic form of plague.

206. With regard to the infectivity of septicæmic plague, no separate information is available; we may, however, refer to the opinions expressed by Lieut. Cornwall, I.M.S., and Lieut. Niblock, I.M.S., that this form of plague may be highly infectious, though death generally supervenes so rapidly that septicæmic cases do not contribute much to the spread of infection. 4371. 12,481.

The bacteriological data with regard to the infectivity of this type of plague will best come up for discussion when we deal with the septicæmic stage of bubonic plague.

Infectivity of the bubonic form of plague.

207. We have not been furnished with any clear instance of infection having been contracted directly from a bubonic case,—the agency by which infection has spread being in the case of bubonic plague generally the soil of the patient's house or his clothes. Instructive in this connexion are the following opinions of witnesses who have had great experience of plague:—

Lieut.-Col. Wilkins, I.M.S., said that he could not call to mind any bubonic case that 504–8.
had infected another case.—Lieut.-Col. Weir, I.M.S., thought that "the simple
glandular form of the disease is practically not dangerous."—Major Dyson, I.M.S., 925, 1165.
said that the bubonic form of plague was not very infectious.—Captain Elphick, I.M.S., 19,964.
said, "I have never seen any other cases except pneumonic cases where anything 9586.
approaching to infectivity appeared to exist."—Mr. Ismail Jan Mahomad thought that 17,789-90.
the bubonic type of plague did not convey infection by mere contact with a patient, 4372–3.
and Lieut. Cornwall, I.M.S., noted that this type could be communicated only by the
evacuations.

VI. (3)(*b*).—*Bacteriological Considerations and Facts relating to the Escape of the Plague Bacillus from the Infected Organism in Septicæmic and Bubonic Cases.*

Bacteriological considerations regarding infectivity of bubonic plague with primary affections of throat and nose

208. From the point of view of their early and continued infectivity, we may perhaps place in the same category as primary plague pneumonia those cases of bubonic plague where the symptoms point to a primary affection of the mucous membrane of the nose, mouth, and throat. In these cases not only is there a possibility of plague bacteria continuing to cultivate themselves on the surface of the mucous membranes where they first effect a lodgment, but there is also the possibility of the bacteria being re-conveyed from the infected glands to the mucous membrane by a back flow of lymph. The only bacteriological observations which are at our disposal in this matter are the following. The plague bacillus was detected in the saliva in each of a series of five cases of parotid and sub-maxillary buboes examined by Dr. Cayley. 25,355. We ourselves succeeded in isolating the plague bacillus from a sanious discharge obtained from the nose of a patient who was suffering from a sub-mental bubo. 26,259.

Bacteriological considerations with regard to non-infectivity of ordinary bubonic plague in early stages.

209. Passing now to the consideration of ordinary bubonic cases of plague, where infective material invades the organism through the skin, it will be manifest that where cutaneous lesions, in the form of phlyctenules and carbuncles, are developed at the site of inoculation, there is a remote possibility that such cases may be infective from the very outset. Cases where a local reaction marks the point of entrance of the bacillus are, however, as we have seen, rare, and the number of plague bacteria which would come into consideration is so small, that the danger of infection from such cases may be practically neglected. In the large majority of cases of bubonic plague, where the infective material is, as we have seen, carried directly from the broken surface of skin to the lymphatic glands, the plague bacteria for a time cultivate themselves only in these glands, and are therefore completely shut off from the surface. Thus in ordinary cases of bubonic plague there will always be a period during which the patient is non-infective. The non-infectious period will extend up to the time when the bacteria make their entrance into the blood.

Bacteriological considerations regarding infectivity of bacterial diseases after septicæmic stage has been reached.

210. As soon as a general invasion of the blood stream has taken place,—and this invasion would seem to occur only in serious cases, and to occur in these for the most part only shortly before death,—it will be possible for bacteria to make their escape from the body through a variety of different channels. We learn from a general study of infective disease what the possible channels are through which bacteria may escape from the organism when a disease has become septicæmic.

The bacteria may, in the first place, become lodged in the capillaries of the skin and of the mucous membranes, with the result that they may give rise there to an exanthematous eruption or to some other form of inflammatory reaction. In connexion with these inflammatory reactions opportunity may be afforded for a throwing off of the bacteria from the skin. In the second place, bacteria may lodge in the capillaries of the respiratory tract—in particular, the lungs—with the result that pneumonic symptoms may be set up, which would be associated with a discharge of bacteria from the organism in the sputum. In the third place, bacteria may be conveyed into the mucous membrane of the intestinal tract, and thence into the fæces. In the fourth place they may be conveyed into the kidneys, and may then escape into the external world by means of the urine. Lastly, bacteria may escape by means of hæmorrhages—in particular, such hæmorrhages may occur from the lungs, the nose, the intestines, and the uterus.

Application of above considerations to the case of the septicæmic stage of plague —(i.) Escape of bacteria from specific plague rashes.

16,794, 20,873, 20,883, 21,020.

Annales de l'Institut Pasteur, Dec. 1899, p. 864.

211. When we come to consider the application of these generalisations to the particular case of plague, the following are, perhaps, the most important points :—

(I.) Cases where specific exanthematous rashes occurred in plague, though exceptional, were observed in Bombay and other places in British India ; they were of extremely common occurrence in the severe epidemic which occurred at Daman. Such rashes, when they occur in plague, take the form of multiple ecchymoses, or, as in varicella and in smallpox, of bullæ or pustules appearing all over the body. In connexion with such cases there will manifestly be opportunity for the escape of infective material from the surface of the skin. In illustration of this point we may refer to the two following cases, which have been bacteriologically examined. In the first of the cases, that described by Drs. Calmette and Salimbeni, the whole body was covered over with pustules, carbuncles (presumably resulting from the breaking down of pustules), and black ecchymoses, " the appearance of the patient closely resembling that seen in hæmorrhagic smallpox. The pustules contained a sero-sanguineous turbid fluid, containing a few cells and enormous numbers of plague microbes, the latter being free in the fluid." The second case referred to above is recorded as follows in the official " Report on Plague in Egypt, from May 1899 to July 1900 " :—" In another case we observed a general eruption of pustules, closely resembling those of varicella, and distributed chiefly over the face and arms. The case was that of a woman admitted to hospital with a left axillary bubo and two small pustules on the left breast (these probably indicating the point of entry of the virus). The general eruption of vesicles appeared two days after the patient's admission. The bacteriological examination of the contents of the pustules revealed the presence of considerable numbers of plague bacilli. The bacilli were not to be found by microscopical examination, but came up in large numbers when cultivated on agar."

Report, p. 51.

(ii.) Escape of bacteria from membranes of the respiratory system.

(II.) In connexion with the conveyance of plague bacteria into the mucous membranes of the nose, mouth, and throat, the possibility must be kept in view that the bacteria may escape from the surface of these mucous membranes. Much more important, however, is the carrying of the bacteria into the lungs, and the setting up of an infectious secondary pneumonia. The development of such secondary pneumonia has been a very frequent feature in certain plague epidemics. In Bombay, in the early months of 1899, about two-thirds of the cases of bubonic plague showed pulmonary complications, varying from slight bronchitis to pronounced consolidation. Even where lung symptoms were little marked, bacteria possessing the morphological and staining properties of plague bacteria were found in the sputum. We found them, for instance, in seven out of a series of 13 cases chosen among those in whom the lungs seemed to be least involved. It would thus seem probable that the sputum must, in a considerable proportion of bubonic cases, be infective. The degree, however, to which the lungs become involved would appear to be very inconstant.

26,256.

21,042.

(iii.) Escape of bacteria into fæces.

(III.) The next point to be considered is the conveyance of the bacteria into the capillaries of the intestinal wall, and thence into the fæces. Investigations have been undertaken with a view to determining whether plague bacteria could be isolated from the fæces of plague patients. The German Plague Commission were uniformly unsuccessful in their attempts to isolate the plague bacillus from the fæces by inoculations and cultivation methods. Report of German Plague Commission, p. 273. —The Austrian Plague Commission were equally unsuccessful; but, in reconsidering their results, they expressed themselves as not altogether satisfied with the technique employed in their examination of the fæces of plague patients. Report of Austrian Plague Commission, Part II. B., p. 544; Part II. C., p. 633. —Dr. Cayley made four examinations with negative results. In a fifth case, where the fæces consisted of almost a pure mucus, he was able to detect the plague bacillus. 25,363–4. —Dr. Gibson examined the fæces and obtained only negative results. 17,271. —We ourselves examined the fæces in four cases, and obtained negative results. 26,391 —Dr. Shrinavasa Rau, on the other hand, claims, by Mr. Hankin's method, to have isolated the plague bacillus in three out of four samples examined by him. 3564.

If we omit from consideration Dr. Shrinavasa Rau's results as results at present quite unconfirmed and obtained by a method which, as we have already said, seems to us to be untrustworthy, Para. 161 of this Report. and if we further omit from consideration the case above referred to where the plague bacillus was isolated by Dr. Cayley from intestinal mucus, the results of the above series of examinations may be summarised in the statement that the plague bacillus has not as yet in any case been isolated from human fæces. Such a negative result is, however, of very little account in view of the fact that it is, as we have seen, a matter of extreme difficulty to isolate, by cultural methods, the plague bacillus from a material such as fæces, in which the bacillus coli and an infinity of other bacteria are to be found. Para. 163 of this Report. The question of the infectivity of the fæces must therefore be adjudicated upon by reference to other considerations than those derived from the bacteriological examinations referred to above. In particular it is to be noted in this connexion that, in a large proportion of the human cases which have been examined, the plague bacillus has been detected in the bile and the gall bladder. Further, it is to be borne in mind that punctate hæmorrhages are not uncommonly found in the stomach and the intestinal canal in man. It is thus probable that the plague bacillus must very frequently be present in the intestinal contents.

(iv.) Escape of bacteria in urine.

(IV.) We now pass from this to consider the conveyance of the plague bacillus into the kidneys, and from thence into the urine. A considerable number of observers have made investigations on this question. The German Plague Commission place on record the fact that they found plague bacteria in the urine in two instances only (the number of their examinations is not specified). Report of German Plague Commission, p. 273. —The Austrian Plague Commission, owing to the contaminations which are nearly always present, entirely failed to find the plague bacillus in urine drawn off during life. They succeeded, however, in detecting the bacillus in 5 out of 17 samples of urine collected in the course of their post-mortem examinations. Report of Austrian Plague Commission, Part II. B., p. 547. —Dr. Cayley examined the urine in 15 cases of plague. His results were uniformly negative. 25,358–62. —Dr. Gibson examined the urine in five cases; he discovered the plague bacillus in only one of these cases. 17,261–2. —Dr. Shrinavasa Rau claims to have detected the plague bacillus not only in two out of four cases where he himself collected the samples, 3558. but also in five out of eight samples of urine, sent to him for examination as having been derived from cases of suspected plague; 3647–9. there is no suggestion that any aseptic precautions were taken in collecting these last samples.—We ourselves examined 60 specimens of urine by cultivation methods. In only three cases were we able to isolate the plague bacillus by this means, contaminating bacteria making their appearance even in the cases where the urine was drawn off with all possible aseptic precautions. 26,268, 26 336, 26,389. In the case of five further samples we sought for the bacillus by inoculating the urine into the peritoneal cavity of guinea-pigs. 26,268. In one of these cases where the inoculated animal died, we succeeded in isolating the plague bacillus from its organs after death.

If we omit from consideration, as we are perhaps justified in doing, the observations of Dr. Shrinavasa Rau, we see that the plague bacillus can only very rarely be recovered from the urine. The difficulty arises from several causes. The first of these is that the urine, even when drawn off through a catheter with such aseptic precautions as are practicable, practically always contains contaminating bacteria. Secondly, the bacilli are probably, unless perhaps in the last hours of life, very sparingly present in the urine. Lastly, it would seem that the urine itself may contain substances which are inimical to the growth of the plague bacillus. This is suggested by the fact that in those cases where we succeeded in recovering the plague bacillus by cultivation methods, the colonies were very slow in making their appearance. 26,337. The virulence of the bacilli which were isolated appears also, so far as we may judge from a single experiment on this subject, to have been considerably reduced.

(v.) Escape of bacteria in hæmorrhages.

(V.) The question of the escape of the plague bacteria into the outer world by means of hæmorrhages from the mucous membranes does not require to be specially considered, it being obvious that hæmorrhagic discharges will, where the blood contains plague bacteria, necessarily contain the infective agent.

VI. (3) (*c*).—*Infectivity of Patients convalescing from Bubonic Plague.*

Bacteriological considerations regarding infectivity of bubonic cases during convalescence, on account of persistence of infection in :—

212. We pass now from the consideration of the infectivity of the plague patient during the septicæmic stage to the consideration of the additional possibilities of infection during the period of convalescence of bubonic patients. These possibilities are associated, on the one hand, with the suppuration of buboes and the discharge of pus which supervenes in a large proportion of the cases in which the disease takes a favourable turn, and, on the other hand, with the continued presence of plague bacteria in the sputum and saliva.

(*a*) Suppurating buboes;

Report of German Plague Commission, p. 265.

Report of Austrian Plague Commission, Part II. B., 509-10.

Annales de l'Institut Pasteur, December 1899, 879.

25,370.

The fundamental fact which we have to place before us in connexion with the suppuration of buboes is that the processes of suppuration go hand in hand with processes of destruction of pathogenic micro-organisms. Thus the question which we have here to consider is really the question as to whether a residuum of the plague bacteria which were originally present is still to be found in the bubo when pus comes to be discharged. A considerable number of examinations have been made with a view to determining this question. The German Plague Commission discovered the plague bacillus in two out of 16 samples of pus from suppurating buboes examined by them. —The Austrian Plague Commission obtained 7 positive and 3 negative results in 10 examinations of pus obtained from suppurating buboes; these buboes, however, had not opened spontaneously.—Drs. Calmette and Salimbeni state that suppurating and open buboes always contain the plague bacillus, characteristic colonies being invariably obtained from them by cultivation methods.—Dr. Cayley examined a considerable number of samples of pus from suppurating buboes. With these he obtained only negative results. From the parts of the bubo, however, which had not yet broken down, he succeeded in cultivating plague bacteria.

The general conclusion to be drawn would appear to be that a residuum of bacteria is discoverable by cultivation methods in the pus from suppurating buboes. It is manifest from what has been said in previous sections, both with regard to the presence of contaminating micro-organisms in suppurating buboes, and also with regard to the difficulty of isolating the plague bacillus in the presence of such contaminating bacteria, that plague bacilli must be present in an even larger proportion of cases than would appear on the consideration of the results of the bacteriological examinations which have been detailed above. No bacteriological observations are available which would allow of our fixing the extreme limit of time within which plague bacteria may be found in the pus of suppurating buboes.

(*b*.) Sputum;

Zeitschrift für Hygiene, 1899, p. 406.

With regard to the length of time during which the sputum may continue infective, we may infer from two cases observed in Alexandria, and placed on record by Dr. Gotschlich, that this may be very considerable. In the first case, plague bacteria were detected in the sputum for a period of 48 days after the temperature had returned to the normal. In the second case, which was one of secondary pneumonia, following upon an inguinal bubo, plague bacilli were detected in the sputum for 20 days after the temperature had returned to the normal. The patients in the two cases in question had been allowed out of bed for 42 and 6 days respectively before the plague bacteria disappeared from their sputum.

(*c*.) Saliva.

25,355

Plague bacteria may escape from the body of a bubonic patient, during convalescence, also by means of the saliva. This source of danger, which probably comes into consideration only in connexion with cases of buboes in the region of the jaws, is consequently of subordinate importance. To be noted here in connexion with it is merely the fact that Dr. Cayley in one of his experiments found the presence of plague bacteria in the saliva 10 days after the patient had, so far as the constitutional symptoms were concerned, recovered from an attack of plague associated with buboes in the region of the jaw. The glands, at the time when the examination was undertaken, were still in a swollen condition.

VI. (3) (*d*).—*Review of Bacteriological Evidence bearing on Infectivity of Patients suffering from Bubonic or Septicæmic Plague.*

Summary.

213. We have seen above that the ordinary bubonic case may be considered as non-infective until the time when the septicæmic symptoms supervene; from that time

onwards the plague patient will become infective by the fact that the plague bacilli escape from the body in the discharges, on the one hand, from the nose, lungs, and intestinal tract, and, on the other hand, from the kidneys. This infective period will, in many cases, last only for a few hours; in other cases it may continue for a few days. In fatal cases, it will, perhaps, roughly coincide with the last 24 hours of the patient's life. In cases which turn out favourably a further possibility of infection will, as we have seen, be afforded by the fact that the pus from the suppurating bubo, as well as the sputum and the saliva, may contain the infective agent.

VI.(4). *Infectivity of Pestis Minor.*

Infectivity of Pestis Minor.

214. In sequel to our discussion on the infectivity of ordinary cases of bubonic plague, we may consider the question of the infectivity of those clinically mild cases of bubonic plague which are classed as pestis minor. In connexion with the infectivity of these we have comparatively few actual observations to draw upon. We shall be compelled, therefore, to deduce our conclusions almost exclusively from bacteriological reasoning.

Dr. Choksy, speaking from a very extensive experience of plague, told us that he had never in his private practice seen any spread of infection from cases of pestis minor in houses where such cases had occurred. Two cases, however, one in Ahmednagar, and the other in the Punjab, have been brought to our notice in which plague infection is said to have spread from cases of plague so mild as to fall into the clinical category of pestis minor. No great weight attaches to the case reported from Ahmednagar, inasmuch as no details were given, and inasmuch as the witness who reported it was not a medical man. Considerable weight, on the other hand, attaches to the statement of Captain James, I.M.S., that the plague epidemic in Gobindpur, in the Punjab, originated from the case of a boy who had contracted plague when on a visit to a neighbouring village, and who had it in so mild a form that he was never obliged to take to bed. 20,575. 24,117-8. 10,099.

It will have become plain, in the course of our discussion of the question of the infectivity of bubonic plague in its different stages, that when the infective agent has found its way into the system through a cutaneous wound, and has afterwards become localized in a gland, then stopping short, as it does in the case of pestis minor, of a general invasion of the blood, the patient will, in conformity with the fact that the plague bacilli are entirely shut in within his body, be quite non-infective; this, of course, not applying to the case already considered above, where the infective micro-organisms have been absorbed from mucous membranes, in which they may still be cultivating themselves. If, however, the disease should develop into the severer form, or if suppuration and discharge of pus should occur during convalescence, opportunity for the spread of infection may be afforded. Neither of these contingencies is very probable, and when they do occur it is by no means certain that plague bacteria will escape from the body. In this connexion a case that occurred at Alexandria is very instructive, although the history as reported is not altogether free from ambiguities. A porter engaged in carrying luggage, which there was strong ground for regarding as infected, fell ill, and on the 5th or 6th of July went to Alexandria, an hour's journey by rail, to see a doctor. He was sent to the Government Hospital. He did not then present the appearance of a sick man, except for the fact that he had a temperature of 102° F. His tongue was clean, and his general condition was satisfactory. In his left inguinal region there was a small swollen gland which was hard and not painful to touch. The patient said that the gland had made its appearance 8 or 10 days before, and that he had had fever and headache for three days. The gland was punctured; the result of simple microscopic examination of the contents was negative, but cultures established the presence of plague bacilli. From the time of his admission the patient's temperature fell steadily and definitely reached the normal five days afterwards. Suppuration of the bubo took place, the pus being, in this instance, found to be free from plague bacilli.

Report of Plague in Egypt, May 1899 to July 1900, p. 64.

VI.(5)(*a*).—*Epidemiological Facts regarding the Direct Infectivity of Rats.*

Infectivity of rats.

215. We have next to consider the possibility of human beings contracting plague by direct contact with infected animals. We need here consider the case of rats only. As far as other animals are involved, such facts as have been brought to our notice are dealt in the section of our Report where we consider the means by which plague is disseminated.

The instances which have been brought to our notice where plague is said to have originated from direct contact with rats are both few and, separately considered, inconclusive. These instances are briefly as follows:—(*a*.) Five cases had come to the knowledge of Dr. Bhalchandra Krishna, where persons in Bombay had developed plague three or four days after handling dead rats. The first four of these cases occurred during the epidemic of 1896, and particulars with regard to them were not to hand. The fifth was the case of a Parsee lady who lived near Girgaum. "She was," said Dr. Bhalchandra Krishna, "taking out rice for cooking, and a dead rat came on to the palm of her hand, and next day she got plague." The patient was under the witness' treatment, and he believed that she had acquired the disease through the uninjured epidermis of the hand by mere contact with the rat. But it must be remembered that, in addition to the disease being prevalent in the City, the house itself had probably been infested by plague-infected rats. It is, therefore, possible that the infection was otherwise acquired than by direct contact with the dead rat in question. (*b*) Mr. Katrak gave us the following history with regard to the origin of a plague case which came under his observation. He said:—"A rat was found in one of the rooms. The patient, before she got the infection, took the rat and threw it out, and then with plain water she scrubbed the ground with her hands. In about six or eight hours she felt a sense of chilliness, then fever began, and she went through the whole course and died." He had heard of another case in which a porter was reported to have removed two or three dead rats from a house, and, "within five minutes," had a sense of chilliness, and subsequently developed plague. (*c*.) A case occurred at Daman of a young woman placing her foot on a dead rat when she returned to a vacated house. That evening she was attacked by plague. (*d*.) Dr. Godinho gave the instance of his own servant boy who developed plague eight days after playing with a dead rat. The witness believed that the boy could not have otherwise been exposed to infection. (*e*.) Colonel McConaghy, I.M.S informed us that a young apprentice fitter in the railway workshops at Karachi, c being ordered to remove a dead rat found in one of the drains, swung the rat about his head and played with it. Three days afterwards he was admitted into the Civil Hospital with plague. There was no plague in the neighbourhood of his house. (*f*.) Major Dimmock, I.M.S., recited the case of a Goanese servant who removed a dead rat from a floor and burnt it. He was attacked with plague four days afterwards. (*g*.) Dr. Simond recounts that at the commencement of the plague epidemic in Bombay a considerable number of dead rats were found one morning in the storerooms of a spinning mill. Of the 20 coolies who were ordered to remove these rats, some 10 contracted plague in the course of the next few days, while the persons who entered the storerooms without handling the rats remained free from infection. Mr. Hankin, to whom the facts were recounted by Mr. Wadia, the owner of the mill in question, gives the number of the coolies attacked as 12.

19,020–27. 17,926. 16,513. 17,996. 11,418. 20,418. Annales de l'Institut Pasteur, Oct. 1898. Annales de l'Institut Pasteur, Nov. 1898, p. 722.

In connexion with these cases, where there are colourable grounds for supposing that contact with a plague infected rat may have been instrumental in the communication of the infection to man, there must be taken into account the infinitely more numerous instances in which the handling of dead rats has not resulted in any evil effects. As an instance of what was constantly happening we may cite here the clearing out of granaries filled with dead rats. We were told by Professor Muller, in connexion with a particular granary which was cleared by him, that none of his gang of 30 coolies was attacked, in spite of the fact that no shoes were worn and no special precautions against infection were taken. We hear, also, in Dr. Planck's Report on Mahamari in Kumaun of "certain children, all of whom have remained well, who, as a matter of pastime, cooked and ate one or more of the rats," found dead in the course of an outbreak of plague in the village of Bintola.

19,437–41. II. 334, para. 118.

We have, in short in reviewing all the facts which have come to our knowledge, little reason to suppose that ordinary casual contact with plague-infected rats, dead or alive, is especially liable to convey plague.

Communication of infection by bites of rats.

216. The case is entirely different where we have to deal with a direct inoculation of infective material by the bites of infected animals. We may refer to a case at Bombay observed by Dr. MacCabe Dallas, where plague is said to have been communicated by a rat bite, and to a similar case reported in detail from Hong Kong. Incidentally, in connexion with the inoculation of plague by the bites of animals we may refer here also to a case in Poona, communicated to us unofficially, where infection is said to have originated in the bite of an infected pet squirrel.

1181. "Lancet,' 1900.

VI.(5)(*b*)—*Bacteriological Data with regard to the Infectivity of Plague-infected Rats.*

Bacteriological data with regard to the infectivity of plague rats.

217. Before bringing to a close our survey of the infectivity of rats, it will be appropriate briefly to reconsider the question in its bacteriological aspect. It will be unnecessary to recapitulate the general pathological principles which in the case of animals, as in the case of man, furnish us with indications as to the possible channels by which plague bacilli may escape from the infected organism. We may pass directly to the consideration of the bacteriological data bearing on the question of the presence of the plague bacillus in the excreta of rats.

Dr. Gibson, without giving the details as to the number of samples examined, informed us that he had been able to discover the plague bacilli in the urine of rats, 17,248-9. and that he had also, by cultivating a series of agar tubes, succeeded in detecting the plague bacillus in the intestinal contents of these animals.—Dr. Mayr told us that he 17,410. had in one instance found the plague bacillus in the urine of rats, and that he had sought for it several times with negative results.—The German Plague Commission put on record the fact that the plague bacillus was found by them in the intestinal contents of rats fed on plague infected material—The Austrian Plague Commission made experiments to determine whether plague bacteria were to be found in the fæces of rats. In the case of four rats inoculated in the peritoneum, and in one rat inoculated subcutaneously, the results were negative; similar negative results were obtained in the case of a rat fed with the organs of a rat which died of acute plague, though the animal which was the subject of experiment died with numerous plague bacilli in its blood. In the case of another rat, fed on the organs of a mouse which had died of plague, bacteria were found in large numbers both in the blood and in the contents of the intestines. In the case of another rat,—the last of the series infected by the intestine,—bacteria presenting the morphological characteristics of plague were found in the intestinal contents, and numerous plague bacteria were recovered from the spleen: a portion of the contents of the intestines injected subcutaneously into a mouse communicated plague to that mouse.—Mr. Hankin told us that he had, on 8602. several occasions, sought unsuccessfully for the plague bacillus in the urine of rats: on one occasion he found the intestinal canal full of blood containing the plague bacilli.

Report of German Plague Commission, p. 284.
Report of Austrian Plague Commission, Part II. C, 634.

Plague bacilli do not appear to have been discovered in the bronchial excretion of rats. It would, however, appear to be probable, in view of the fact that pneumonic changes have been found in the lungs of rats, and in view of the fact that the plague bacillus has been found in considerable numbers in the bronchial secretions of guinea-pigs hypodermically inoculated with plague, that the bronchial secretion may, also in the case of rats, be infective.

As in the case of man, so also in the case of rats, plague bacteria have been recovered from the pus from suppurating buboes. In the opinion of the Austrian Plague Commission the disease may not infrequently be disseminated in this way by rats that are recovering from the disease.

Report of Austrian Plague Commission, II. C, 686.

VI.(6)(*a*).—*Epidemiological Facts regarding the Infectivity of Houses.*

Infectivity of plague houses and data with regard to persistence of infection.

218. We now proceed to discuss the question of the infectivity of houses and rooms in which plague cases have occurred, or which have been infected by animals. Proof of the infectivity of such houses can be obtained by showing that the entry or re-entry of healthy persons, who have not otherwise come into contact with plague into empty houses, vacated because of the disease, has been followed by the occurrence of cases among them.

Instances of infectivity and persistence of infection in houses where plague cases have occurred.

219. Examples of plague infection due to re-entry into infected houses are available in connexion with village epidemics where the inhabitants were allowed prematurely to return from evacuation camps to their villages. Instances in point are set forth in that section of our Report which deals with evacuation.

Para. 632 of this Report.

Other instances have been placed on record in connexion with the return of people to individual houses which have been inadequately disinfected; some of them are set forth here. Mr. Giles, the Commissioner in Sind, put before us several instances of this kind.—In one of the instances which he cited plague occurred in a house on the 11,266. 27th of March 1897; the room in which the case occurred and the adjoining room were disinfected and left empty till the 15th of April. A man who went to live in the room about this time was attacked by plague on the 18th of April. The whole range of rooms was then again disinfected, and the roof was entirely removed and burnt, permitting the sun to pour in, the burnt walls and the beams alone being

left standing. On the 14th of May, three weeks from the date of the last case, a man
who had gone to the house but had not slept in the infected room, and who used the
room merely as a cooking place for two or three days, was found there ill with plague.—
11,271. In another instance, a family which had been segregated, was, after the disinfection
of their clothes, allowed to return to their house, which had been chemically
disinfected and vacated for some time. The number of people who returned to the
house was seven, and five or six days after their return one member of the family was
11,276. found dead of plague and three others were found to be ill with the disease.—In
another instance, a small house was disinfected and its roof was removed and burnt
on the occurrence of a plague case on the 5th April 1897. On the 20th April the
residents of the house were allowed to return to it from the segregation camp. On
11,276. the 24th April another case of plague occurred in the house.—Similarly, a woman
contracted plague four days after return to a house which, on the occurrence
of a plague case, had been disinfected and unroofed and remained empty for between
11,276. three and four weeks.—Another instance given us by Mr. Giles was that of a large
and not ill-ventilated house which was, on the occurrence of a case of plague in it,
very thoroughly disinfected; about a week after the people of the house returned to it
11,276. from the segregation camp another case of plague took place in the house.—In
another instance, Mr. Giles said that a house was disinfected on the occurrence
of a case of plague in it, and remained closed for about a month; the man who then
reoccupied it was at once attacked by plague. Mr. Giles summed up his experience
11,268. of Karachi by saying: "I was out pretty nearly every day, and one kept on coming
across cases of people going back and getting plague."—Similar to the experience
Capt. James' of Mr. Giles was that of Captain James, I.M.S., in the Punjab. "It is astonishing,"
Report, p. 107. says this observer, "how long infection remains in and about the rooms and
buildings where cases of plague have occurred—that is, when nothing has been
done to kill the contagion. In Mahlgahla, people returning to the village 40 days
after the evacuation were attacked; at Khan Khanan 38 days; at Kariha 30 days; at
Mallupota 31 days; and at Bahrwal 24 days after the village had been emptied."—
22,384-5. A remarkable history is that of the house of the jailer at Satara, regarding which
22,535. evidence was given to us by Mr. Dodgson, Lieut.-Colonel Hay, Captain Thompson,
22,137. I.M.S., and Mr. Ghanekar. A case of plague occurred in January 1898 in this house,
22,330. which is a large one of stone, well built and well ventilated. After this the house
22,549. twice underwent disinfection. Another case occurred in the house on the 20th
22,062. December 1898, and the house was then again thoroughly disinfected, but ten days
20,331-8. after the return of the inhabitants two more cases of plague took place.—Remarkable
also in connexion with the local persistence of infection are the facts brought to our
notice in connexion with the outbreak of plague in the Umarkhadi Jail at Bombay.
Four cases occurred in the jail at the commencement of the outbreak, all in prisoners
who had been sleeping in one particular spot. The barrack in which they had been
sleeping was then evacuated and carefully disinfected. When the barrack was re-
occupied, three weeks after, three more cases occurred in other prisoners who slept in
the same portion of the building as those first attacked. It is to be noted that the
prisoners in the jail are continually moved about, and are never allowed to sleep con-
22,549. tinuously in one particular place or one particular barrack.—Mr. Ghanekar told us that he
24,451. knew of about ten cases in Satara where plague kept recurring in a house.—Mr. Moore
23,196. had noticed one or two cases of the same kind both in Bulsar and Surat.—In Igatpuri,
Major Anderson, I.M.S., found that plague cases frequently occurred in infected
houses that had been disinfected. He instanced particularly the case of two chawls,
each of which, though it had been disinfected four or five times, continued to furnish
cases until the inhabitants were removed.—Lieut. Firth noticed, in the case of Bombay
25,790. chawls which had been emptied and disinfected, that when the people returned in a
"fortnight or month, or any length of time, as soon as you put them back again they
got plague just as badly."

Instances of infectivity and persistence of infection in houses infected by plague rats. Para. 192 of this Report.

220. There can be no reasonable doubt that what holds true with regard to houses which have harboured plague patients holds true also of houses which have been infected by plague rats. In the latter class of cases it will, however, be more difficult to discriminate between infection contracted from the house and infection contracted directly from contact with rats. Such a case, for instance, is that of Chak Kalal, an evacuated village in the Punjab, already referred to as a village where a serious outbreak of plague occurred among the inhabitants on their re-entry into their houses. It is not clear whether the infection was contracted

directly from rats that had died of plague, or from the houses that had been infected by those rats. In the absence of a history of direct contact with rats, it would in such cases seem reasonable to assume that the infection was contracted from the house. Instances of the contraction of infection on a smaller scale from rat-infected houses are the following.—In the case of Mahlgahla a severe epidemic of plague broke out 10,348. among the inhabitants who returned to disinfect their houses, which were uninfected Paras. 192 and 273 of this Report. when vacated some month previously, and in which dead rats were found at the time of disinfection.—Further observations regarding the occurrence of plague among Para. 303 of this Report. disinfecting staffs employed on infected houses will be found in a subsequent section of this Report.—In the village of Holihosur, dead rats were found in December, and 22,943. as a precautionary measure the village was then evacuated; no one suffered from plague until a month afterwards, when the people, thinking they were safe, went back to the village. Plague cases then began to occur.—Three people were attacked 11,421. by plague in a house in Karachi three or four days after mortality among rats had been reported in that house.—Speaking of a particular house in Bombay City, Lieut.- 1,180. Colonel Weir, I.M.S., informed us that rats were found dead in it. Thereupon, the inmates, with the exception of three persons, vacated the house. One of these three persons was attacked by plague ten days afterwards, no connexion with any other source of infection being traceable.—In another house in Bombay, where the rats 20,416. were found dying and where the European inhabitants neglected to take the proper precautionary measures, some of the servants were attacked with plague, and a few days later one or two also of the Europeans were attacked.—The appearance of dead 18,189. rats was, as we were told by Mr. Shroff, in the case of houses on Malabar Hill, followed by cases of plague; among these was notable the case of a man who 18,196. persisted in sleeping in a room where dead rats had been found.

It is, however, important to note that the finding of dead rats has not in all cases been followed by the occurrence of plague among men. Doongri may be mentioned as a place where there was no plague among men, though dead rats were found there 14,377. and there was plague in the neighbourhood. In the village of Sherli, near Bombay City, an epidemic of plague occurred among rats which was quite unaccompanied by 18,966. any plague among men. In the Fort of Daman, "in about 40 houses, dead rats were 15,960. found. Notwithstanding this, no single case of plague occurred in the Fort." No doubt most of the residents of the Fort were inoculated, but this, in view of the Sect. IV.(3) of Chap. IV. of this Report. general results of inoculation in Daman, can hardly have accounted for the complete absence of plague. Again in Kankhal, though in the month of June, 1897, some 9291-3. 30 dead rats were found chiefly in and about a particular grain store, no plague cases 8590. occurred among men in association with this rat epidemic, and no dead rats were Annales de l'Institut Pasteur, Nov. 1878, p. 749. found for five or six weeks before the first cases among men occurred.

Conclusion that infection persists for long periods in houses in which it is introduced by men or rats.

221. To sum up, the universal experience of plague in India proves—and we shall deal with this matter when treating of the question of disinfection—that houses into which the infection of plague has been imported, whether by men or by rats, are infective, this infectivity being so marked that many of the officers who have had most experience of the disease, have come to the conclusion that the principal source of infection is, as would appear to hold true in the case of yellow fever, and possibly also of typhus, to be found in the houses into which the infection of plague has been introduced. The general experience on this question is summed up in the expression current in India that plague is essentially a "disease of locality." 1650, 18,108.

VI.(6)(*b*).—*Bacteriological Observations regarding the Existence and Persistence of Infection in Houses and in particular in Earth and Cowdung Floors.*

Bacteriological observations relative to the presence of the plague bacillus in floors.

222. It would undeniably be of advantage to obtain definite information, first, as to the presence or absence of the plague bacillus in houses suspected of being infective, and, secondly, to obtain light on the question as to whether the infective properties of a house where plague has occurred depend merely upon the continued survival of bacilli which have escaped from the organism, or are due to a multiplication of such bacilli by saprophytic growth. Many series of bacteriological investigations have been undertaken with a view to throwing light upon these questions. The material which has been subjected to examination has been for the most part material derived from the earth and cow-dung floors of native houses, which, since there is very little furniture in native houses, and since the people eat, sit, and sleep, on the floor, would appear to be the most likely carrier of infection. The investigations in question have been already considered by us in discussing the special technical methods employed. The general

Paras. 160-2, and 167 of this Report. 25,374-88.

results of the examinations referred to—and we may note that, in conformity with these, are the results obtained by Dr. Cayley in a series of 30 to 40 examinations of samples of earth collected from plague-infected houses, to which examinations we have not previously referred since details as to the technique employed are wanting—may be summed up in the statement that in the very numerous series of examinations made in India, the plague bacillus has never been detected in the floors by any trustworthy observer. Needless to say these results do not in any way establish the absence of the plague bacillus from the material examined. They prove merely that the plague bacillus cannot, with the present methods, be detected in earth, and that inferences made in particular cases as to the infectivity of houses cannot at present either be confirmed or refuted by bacteriological investigations.

Bacteriological observations regarding the persistence of plague infection in earth.

18,865-80.

223. In default of methods allowing of the detection of the plague bacillus in earth under the conditions which obtain in nature, information of a useful character, bearing on the question of the persistence of infectivity in houses, can be obtained from experiments in which sterilised materials are artificially infected by cultures of plague. Dr. Marsh has conducted a series of such experiments. These showed that when the plague bacillus is introduced into moist sterilised garden earth, it is capable, under the particular circumstances which obtained in Dr. Marsh's experiments, of surviving there for a period of 13 days. The period of survival of the plague bacillus in moist sterilised cow-dung was found to be practically unlimited, the bacillus being still recoverable by cultivation after a period of many months. A further interesting fact elicited by Dr. Marsh, and already incidentally referred to, which has an indirect connexion with the question of the growth of the plague bacillus in earth and cow-dung floors, is the fact that agar cultures when buried under the floors of native houses were found to grow in a particularly luxuriant manner this luxuriant growth being, as further experiments demonstrated, probably due to the presence of carbonic acid in the ground air. These experiments would seem to suggest that the plague bacillus may find certain conditions which are favourable for its development in the floor of native houses.

Para. 162 of this Report.

Bacteriological observations regarding saprophytic growth of plague in earth. 26,132.

224. With a view to testing in a preliminary manner the possibility of a saprophytic growth of plague in earth, we performed the following experiment:—We took 12 small glass tubes, each pierced with a lateral hole, the holes in different tubes being arranged in such manner that earth could be withdrawn from the different tubes at progressively increasing depths from the surface. These tubes were filled with sterilised earth and plugged with cotton wool. The lateral hole of each tube was closed by a tight fitting india-rubber band. The earth in six of the tubes was moistened with sterile water; the six other tubes were kept dry. A drop of fresh plague culture was dropped on the surface of each tube, and the tubes were kept at the ordinary temperature of the room in a diffused light. When they were examined after four days, the plague bacillus was neither to be found on the surface of the tubes, nor in the earth withdrawn at different depths below the surface. Manifestly very little importance attaches to an experiment like this. So far, however, as it goes, it does not lend support to the view that the plague bacillus finds in the earth very favourable conditions for saprophytic growth.

VI.(7)(*a*).—*Epidemiological Observations bearing on the Infectivity of Clothes and Fomites and the Persistence of Infection in them.*

Infectivity of clothes and fomites; epidemiological data. Para. 239 of this Report.

11,961.

225. There can be no doubt, on general considerations, that clothes and fomites must be infective, and may retain their infection for a long time.

Striking proof of such infectivity is furnished, by specific instances of infection from clothes. Most of these are cited in the section of our Report which deals with the importation of infection into uninfected places. One interesting example, however, which was furnished to us by Lieutenant Law, I.M.S., may be set forth here. In July 1897 at Kiamari a case occurred among the Mahrattas, after a considerable interval during which there had been no plague in the neighbourhood. It was ascertained that the patient had three months previously come into possession of some clothing deriving from a person who died of plague in another house. These clothes had apparently been kept in a box, which was opened only shortly before the patient who came under Lieutenant Law's observation fell ill.

In addition to the specific instances to which we have just referred there are also certain general observations pointing to a more general spread of plague in camps by means of clothes. It will be manifest that where in the case of evacuated villages effectual precautions have been taken to prevent the access of people to their houses, and where the sick among the evicted population have been carefully segregated and the infection in their huts destroyed, the continued occurrence of cases of plague in camp can hardly be imputed to anything else than the persistence of the infection in clothes and fomites. Confirmation of the view that the continued occurrence of plague in camp under these conditions is due to the presence of infection in clothes is afforded by cases when the plague ceased in camp after the clothes and effects had been carefully disinfected.

A notable instance in point is that of Shikohpur, an infected village in the Punjab. With reference to this village, Captain James, I.M.S., says:—"The people were all got out into the camp by February 2nd. . . . Even after the people came out, 9994. dropping cases occurred among them, in consequence of which Dr. Walton had all the goods and property in all the camps disinfected. The result was immediate; the disease stopped, and, with the exception of one isolated case of a man on the disinfecting staff, who was attacked on March 3rd, no new cases occurred." Captain 10,145-6. James told us that he had, in the case of health camps, seen several instances of a similar effect following the disinfection of personal effects, Mallupota and Bahrwal being specifically mentioned as places in which plague was suppressed in the health camps by the disinfection of clothes and the removal of the camps to fresh sites. In the wide experience acquired in the course of his plague operations in the Punjab villages, Captain James, I.M.S., found that, in order to prevent their reintroducing plague from camp into their disinfected villages, it was, generally speaking, necessary to keep the people out for three weeks after the last case in camp. "In the middle of the cold weather, and in February, when the disease did not die Captain James' Report, p. 114. out so quickly after people went into camp, we," says Captain James, "allowed a month to elapse after the last case before permitting the people to return to the village."

To return to the question of the suppression of plague in camp by the disinfection 21,254-7. of clothes, we may refer to the evidence given to us by Lieut.-Colonel Fawcett, R.A.M.C. This witness told us that on the 5th of October 1897 cases of plague began to occur in the Transport lines in the Poona Cantonment. By the 4th of November 24 cases had occurred, so the whole of the followers and their families—altogether about 400 persons—were moved into camp. This measure, however, was not of itself found sufficient to stop the disease. Fourteen cases occurred in the camp, so on the 13th of November it was decided to move the camp a short distance, and to apply a thorough process of disinfection to the persons of the inmates of the camp, to all their clothes and property of whatever kind, and to their tents. This decision was carried out. After the careful disinfection of everything, the camp was moved a few yards across the road. Two children who were found to be ill before the removal were isolated, and after the disinfection and removal had been accomplished not a single instance of plague occurred among those who crossed the road.

The conclusion that the wholesale disinfection of clothes and personal effects, and 21,521-3. not the removal of the camp, was probably the operative agent in stopping plague would appear to be supported by the consideration of the contrasting case of the three Native Infantry Regiments which were about the same time attacked with plague at Poona. The first of these regiments, the 19th Bombay Infantry, was attacked with plague and moved into camp on the 29th of September 1897. Nineteen cases occurred in their camp, and they were then, on the 15th of October, moved to another camp without disinfection of their effects. In the second camp seven cases occurred before the plague stopped. The 2nd Bombay Grenadiers, on being attacked with plague, were moved into a camp on the 29th of September; between 29th of September and the 23rd of October 11 cases occurred among them in camp, and on the 23rd of October their camp was moved, without disinfection of their effects, to another position. After two more attacks had taken place the plague stopped among them. The depôt of the 14th Bombay Infantry was, on the outbreak of plague, moved into camp on the 28th of October, and five cases occurred in camp before the 18th of November. The camp was then, without disinfection, moved further from the Cantonments, and no more cases took place. If we take into consideration here the fact that the removal of the camp, combined with precautions against the re-introduction of infection and with disinfection of clothes was followed by the complete extinction of plague in the case of the Transport followers who had 14 cases of plague in their first camp, while the removal of the camps combined with precautions, as in the case of the Transport followers, but without disinfection, was followed by nine cases in the case of the regiments, which had in their first camps an aggregate of 35 cases, it would appear that a certain amount of infective material must have been harboured in the clothes.

Paras. 304 and 305 of this Report. The inference that clothes are infective would appear to be confirmed by the frequent occurrence, noticed elsewhere in this Report, of plague among washermen and others who are brought into close contact with clothes which may derive from plague patients.

VI.(7)(*b*).—*Bacteriological Observations regarding the Infectivity of Clothes and Fomites.*

Bacteriological data relating to the infectivity of clothes.

226. In view of the difficulties associated with the isolation of the plague bacillus
when mixed with contaminating bacteria—difficulties which have been already suffi-
ciently brought forward in connexion with the bacteriological examination of earth,—
the detection of the plague bacillus in clothes and similar effects has only in a few
8627–8. instances been attempted. Mr. Hankin examined, by inoculation into mice, a certain
number of specimens of the clothing of people who had plague, or who had died of
619–20. plague: he failed to find the plague bacillus.—Dr. Gibson examined, by cultivation
methods and by inoculation into animals, two specimens of wearing apparel from
25,347–51. plague-infected patients. In neither case was the plague bacillus detected.—Dr.
Cayley also examined clothing of plague patients, obtaining only negative results.
25,393–6. The plague bacillus was, however, detected by Dr. Cayley in a portion of matting
which had been used for the bedding of a plague patient, and was soaked with his
discharges. This, however, was a case of gross contamination.

Para. 659 of this Report. Details regarding the length of time for which the bacillus of plague may survive in clothing into which infection has been artificially introduced will be set forth later in connexion with our discussion of the disinfection of clothes.

VI.(8).—*Infectivity of Merchandise.*

Infectivity of merchandise.

227. In connexion with the question as to whether merchandise is to be regarded as infective, certain *à priori* considerations may, perhaps, appropriately be set forth here. The presence of the infection of plague in articles of merchandise is conceivable only when these have been contaminated either by the excreta of plague patients or of infected rats. The only merchandise which comes into consideration in connexion with contamination by men is rags; the merchandise which comes into consideration in connexion with possible contamination by rats is grain and other food stuffs and merchandise which has been stored in close vicinity to food stuffs. Thus such merchandise as hides, prepared with arsenic, as the Indian hides are, and unused gunny bags, will be little liable to contamination.

In determining whether any particular articles of merchandise are infective or as to how
long infection may persist in them we must rely chiefly upon the facts which have come to
Sections VII.(4) and IX.(2) and paras. 262 and 301 in this Chapter. light with regard to the importation of plague into uninfected places, and with regard
to the spread of plague within infected places and the question of the special liability
of traders to contract and spread plague. Certain isolated observations, however,
which do not come naturally into the discussion of the matters just referred to, but
would seem to throw a light on the possibility of infection through merchandise, may
23,005. be set down here. "In a village which I came to about 10 days ago," said Lieut. Kidd,
who was engaged on plague duty in the Belgaum district, "a Banniah had got the
plague, and a woman who bought some grain from him, got plague four days
afterwards. The Banniah's daughter had died of plague, and I could not trace how
this woman had got plague in any other way, as she was living in a hut at least 100 yards
away from any other hut, and she had not been in the village for a month, and none
23,006. of her relations had died of plague." In response to a question as to whether the
woman might not have contracted the infection by direct contact with the Banniah's
daughter while she was still alive, the witness said, "Yes, that is possible. This
Banniah was living in a hut, and he had all his stores outside the hut on a little
verandah, and I do not think the women who went to buy grain went into the hut;
she would have stayed outside." Lieut. Kidd moreover, told us that in the village of
Mohol, where "many Banniahs had the plague, some Mangs stole their grain, and a
23,004. few days many Mangs got the plague." In reply to a further inquiry, Lieut. Kidd
said, "of course they might have caught it through going into an infected house."
12,446–7. The following was reported to us by Lieut. Niblock, I.M.S. On the 27th of May two
cases occurred among Musalmans in the village of Reri, near Karachi, in which plague
had broken out among Banniahs connected with a particular shop. The cases in question
were those of a boy and a girl who were not related to each other, who had not been to
Karachi for months, who lived in huts far from each other and from the shop of the
infected Banniahs, but who bought their eatables and grain from the shop in question.

Bacteriological data regarding infectivity of merchandise.

228. Coming now to bacteriological observations made with regard to the infectivity of articles of merchandise, we may note that Mr. Hankin subjected to bacteriological investigation a formidable number of different articles of merchandise, in particular, seeds and other vegetable products, and that he obtained in every case a negative result. Lieut.-Col. Lawrie, I.M.S., basing himself on cultures and inoculation experiments made by Dr. Mullanah, claimed in the public press that the bacillus of plague had been discovered in raw cotton packed for transport. It appeared, however, 25,903-9; 24,820-94. from our examination of Dr. Mullanah that this witness considered that there was not sufficient evidence for identifying the bacillus isolated by him from cotton with the plague bacillus. 3482-6. Dr. Shrinavasa Rau, who, as we have seen, claims to have isolated the plague bacillus from so large a proportion of cases of fæces and urine examined by him, claims to have detected the plague bacillus in specimens of coir suspected of having conveyed the infection into Bangalore Jail. It will probably be quite unnecessary at this stage of our report to point out that the negative result of Mr. Hankin's experiments affords us no warranty for inferring that the plague bacillus was in reality absent from all the samples of merchandise examined.

Persistence of infection in merchandise.

Paras. 262 and 659 of this Report.

229. The question of the length of time for which the plague may survive when artificially introduced into articles of merchandise, will be most appropriately dealt with in connexion with the spread of plague over sea, and with the question of the application of measures of disinfection to merchandise.

VI.(9).—*Concluding Remarks regarding the Infectivity of Plague.*

Concluding remarks with respect to the infectivity of plague.

230. Before bringing our consideration of the infectivity of plague to a conclusion, it will be useful briefly to summarise what has been said above.

Observations on the sick in hospital have shown us that in plague the risk of direct infection from patients, taken in the aggregate, is a small one. We have, however, seen that primary pneumonic plague constitutes an exception to the general rule, and that this type of the disease is highly infective. The same must be assumed to hold true of those exceptional cases of plague in which specific plague rashes, of a bullous or pustular nature, appear on the surface of the skin. Quite of a different order is the infectivity of the ordinary bubonic form of plague. In this, which is by far the most common form of plague, the infective material is not thrown off from the surface of the skin, or to any considerable extent from the lungs, but appears only in the excretions, and this only in the last stages of the disease.

We saw that what holds true with regard to the escape of infective material from the human plague patient probably applies, in a general way, also to the escape of infective material from the organism of plague-infected rats.

With regard to the indirect infectivity of plague, we have seen that the house in which plague patients or plague rats have died, and the clothes and other effects which have been soiled by the excretions of plague infected men and rats, are infective. All these, when they have once been contaminated, may remain infective for very considerable periods. Thus plague, which is in certain of its manifestations formidable from the point of view of its direct infectivity, is formidable also in all its manifestations, except that of pestis minor, from the point of view of its indirect infectivity, especially from the manner in which infection clings to contaminated houses and personal effects. We shall see that the danger which accrues to those who live in infected houses would appear to be much greater than that which accrues to persons who merely come in contact with plague patients, and this is in harmony with the doctrine of chances, seeing that the bacillus escapes from the body, for the most part, only shortly before death, while it is capable of surviving and communicating infection for long periods after it has escaped from the organism.

Measures adopted in India have prevented infectivity of plague exerting its full force.

231. The full measure of the infectivity of plague has not, we think, been at all fully disclosed in India, inasmuch as in the overwhelming majority of cases measures have been taken either to extinguish the infection in infected houses or to remove the people from these the most considerable sources of infection. In exceptional cases, however, where, generally owing to the fact that the presence of plague has been concealed from the authorities, or where plague measures were suspended owing to heavy rains, and where, consequently, the people have remained exposed to the unabated force of the infection, plague has had an opportunity of doing its worst. In illustration of what the ravages of plague can be when the people remain in their houses and in contact with the sick under conditions which are also otherwise favourable to the spread of the disease, we may point, on the one hand, to the facts set forth in paragraph 125 of this Report with regard to the terrible mortality recorded in certain places in India, and, on the other hand, to individual instances which were brought to our notice, such as the following:—In a case which came under the personal observation of 1725. Mr. Cappel, the Collector of Hubli, nine uninoculated persons died of plague in the

23,383. family of one of his clerks. Only four members of the family, and these all inoculated,
survived.—In a case in Hubli, reported to us by Lieut. Thomas, nine persons out
of a family of 13 died in a house before the existence of plague became known to
3698. the authorities.—In a case cited by Mr. Cadell 13 out of 18 inhabitants of three
12,383. adjoining houses in Karachi succumbed to plague.—In a case in Karachi, reported by
Lieut. Niblock, I.M.S., in spite of the attempts which were made to isolate the
patients in their own room, 24 out of 40 persons in one house succumbed to plague.—
5498. In a case cited by Mr. Stevens 9, or 11, persons—the exact number was uncertain—
died of plague in one house in a village in the Hyderabad State.—In a case in Calcutta,
II, p. 537. reported by Major Green, I.M.S., where the patients were not removed to hospital,
eight out of a family of 15 succumbed to plague.—In another case in Calcutta under
the same conditions 11 persons died in one hut, and of these, four, all members of
one family, died in one room.

While facts like the above are of the utmost importance as an indication of the full measure of the infectivity of plague, it may reasonably be assumed that there must have been many cases in which the introduction of plague into overcrowded chawls has not been followed by any spread whatever of the disease.

VII.—CONVEYANCE OF PLAGUE FROM INFECTED TO UNINFECTED PLACES.

Information regarding agencies by which plague is conveyed into uninfected places not obtainable from history of large towns, but of villages. Paras. 11-13, 41, 57, 61, 74, 92, 95, 102, and 105, of this Report.

232. It has been clearly indicated in the historical section of our Report that the origin of the outbreaks of plague in Bombay and other large towns in India has never been satisfactorily elucidated, and is a problem which it is impossible to resolve. This is not surprising, for in the case of the large cities in India the authorities were either taken unawares by the advent of plague, or were unable to take any effective measures anterior to the advent of plague for the detection of the first case that might be imported, or, in default of such an imported case, the first local case which might originate from infection otherwise introduced. If we look beyond the limits of India, we see that attempts made to elucidate the manner in which plague was imported have been no more successful in Hongkong, Alexandria, Oporto, Sydney, Glasgow, and other places, than similar attempts made in the large towns of India. It will thus be manifest that no light will be thrown upon the question of the mode in which plague spreads from place to place by an examination of the history of plague in large towns. In the case of each such town, we remain in doubt whether the infection was imported by a patient who was already infected elsewhere, or by infected rats, or indirectly by means of infected clothes or merchandise. The important problem as to how far each of the agencies just referred to is concerned in the spread of plague from place to place is, however, one which can be elucidated by studying the mode in which plague was introduced into villages throughout India. In villages the conditions for the discovery of the mode of infection are comparatively favourable, and in many cases the mode of infection was actually ascertained.

VII.(1).—*Introduction of Infection by Human Communication.*

Conveyance of infection from place to place by human communication.

233. The evidence which has been placed before us shows, in the clearest manner, that in many cases plague has been introduced into a place by a person arriving from a plague-infected locality. In many cases this person has himself sickened of plague; in other cases, the person who introduced the infection escaped, while others contracted the disease.

Captain James, I.M.S., who was in charge of the plague operations in the Punjab,
10,078-9. told us that in that Province, out of a total of some 90 villages infected, the origin
of the disease had in 67 cases (including cases of re-infection) been traced to the
importation of the infection by human agency. Under the heading of villages which
were infected by human agency, Captain James included not only the villages which
were infected by the arrival of a plague patient, but also the villages which were
infected by the introduction of the infective material brought by a person who did not
himself develop plague. Captain Wilkinson, I.M.S., whose experience covered the same
field as that of Captain James, expressed the same opinion, observing that the facts
10,391. supported the idea of the importation by the human conveyance of plague "strongly.
In a large number of villages the first people to be attacked were," he said, "people
who were known to have gone to infected villages."

Again, Major Anderson, I.M.S., who had great experience of plague, both in the
23,207. rural and the urban areas of the Bombay Presidency, told us:—"In most places, as
in Kurla, Bassein, Chembur, Trombay, Malad, Chinchni, Thana, Bhiwandi, Bhayndar,
&c., we have a history of persons coming sick from an infected locality, or falling sick
a day or two after their arrival prior to the occurrence of local cases." Major Anderson
23,207. placed before us the following specific instances:—" In Agashi, the first local case

occurred in the person of a Shimpi woman, to whose house some friends from Bombay had come to live. None of these Bombay people were sick or were afterwards attacked. In Kelwa, also, the first local cases occurred in the person of two Shimpis to whose house some Shimpis from Bombay had come five days before. These Bombay people were in good health, and after staying three days returned to Bombay . . . . At Versova a striking instance of the disease being carried by an apparently healthy person occurred. The first imported case at Versova occurred on 30th January in the person of a Brahman who came sick from Bombay. The Brahman schoolmaster of Versova visited this man while he was sick, and attended his funeral on 31st January. The schoolmaster lived in the village Talati's house. On the 2nd February the Talati's nephew, who lived in this house, was attacked by plague, while the schoolmaster himself was not attacked till the 5th of February. In Marol also the first case occurred in a house to which a number of people had come from Bombay to attend a wedding. These people were in good health, and after staying some days they returned to Bombay in good health . . . Again, in the village of Madhan, an isolated case occurred prior to the outbreak there, in the person of a man to whose house a man from Bombay had come to live."

Six cases of plague broke out on the 2nd of October in a village called Ugargol, 22,878–85.
situated in an uninfected part of the Belgaum district. It appeared that the owner of the house in which the outbreak occurred had, in the middle of August, returned to
the village from Dharwar, which was then infected; he had not since been to Dharwar, 22,879.
and Mr. Carmichael satisfied himself that he must have introduced the infection from Dharwar in some infected article, six weeks before the disease broke out in his house.

Both Major Anderson, I.M.S., and Mr. Carmichael thought that in the cases cited 23,206.
by them and similar cases the infection must have been imported, not on the
person, but in clothes or some other article. In these cases, however, unlike those Sections VII.(3) and (4) of this Chapter.
cited later in connexion with the importation of plague in clothes and merchandise respectively, no particular article was incriminated.

In the Dharwar district, where, after the evacuation of the chief town of the district 1641.
the epidemic was very widespread in the villages, Mr. Cappel told us that the plague
was conveyed from village to village by human agency. Mr. McNeill, Mr. Cappel's 2039.
successor in charge of the Dharwar district, who had also been employed in measures against the plague in the Surat district, said:—"As far as my experience goes, I think it was carried by human beings. That seems to explain almost every case that I came
across." Captain Colomb, on his experience of plague in the Dharwar district, came to 23,626.
the conclusion that "as between villages, so between huts or groups of huts, the spread
of infection can always be traced to human agency." Rao Bahadur Bhardi, Deputy 23,502.
Collector, who also was employed on plague duty in the Dharwar district, said that infection was carried without doubt from village to village by human agency.

In the Sholapur district also, and in the adjoining parts of the Hyderabad State—which became severely infected after the evacuation of Sholapur City—the influence of human agency in spreading plague was shown in the most complete manner. Mr. Stevens,
the Deputy Plague Commissioner for the Nizam's territories, gave it as his opinion 5198.
that plague is conveyed "by people suffering from plague going into villages and giving it to others." He had discovered many refugees suffering from plague in the
villages under his charge. Lieut. Bruce, who made observations on the spread of 24,016.
plague in the villages of the Sholapur district, thought that the disease was spread mainly by human agency.

Lieut. Steen, employed in the infected villages of the Satara district, thought that 22,678.
infection was conveyed "almost entirely by the visits of people of infected villages
to non-infected villages." In seven of the villages under his charge infection was 22,690.
clearly traced to human beings; in no case was it traced to any other source.

Similar evidence as to conveyance of the infection of plague into uninfected places
was placed before us in connexion with Bulsar. "I think," said Major Dyson, I.M.S., 19,941.
"it is spread by human agency from place to place. In the case of Bulsar, plague was undoubtedly introduced from Bombay, and, I think it was introduced in this way into
Surat also, though I cannot speak positively about that." Mr. Moore, who had 24,409.
experience of outbreaks both at Surat and at Nasik, was of opinion that Surat became infected by people who went to Bombay, "became infected in Bombay, and then
came back to spread the plague in Surat." Mr. Stewart, from his experience of Nasik, 16,966.
said that plague is, as a rule, brought into a place "by people who are infected." He remarked that "people come from infected places and live in clean houses and apparently after some time they infect the houses." Dr. Maynard, employed for some time as Civil Surgeon at Nasik, thought that the spread of plague was caused "by the

14,693. villagers in their ordinary course of moving from one village to another, generally by the class which corresponds to that of grocers, people who deal in small quantities of grain. It was noticed at first, more particularly among the grain-sellers in Nasik."
14,694. He said : "I do not think it has anything to do with what they deal in. I think it is because the people travel from one village to another."

24,089. Mr. Hudson, the Collector of Ahmednagar, thought that the conveyance of plague from village to village was nearly always "by human agency." Similarly,
15,200. Mr. Dhurandhar, the Sanitary Commissioner for plague operations in the Baroda State, gives it as his opinion that the danger of the spread of plague by infected persons from place to place was very great, and added that the infection was carried "by human agency mostly."

VII.(2)(*a*).—*Introduction of Infection by Rats.*

Conveyance of infection into an uninfected place over land by the agency of rats.

234. In dealing next with the question of the conveyance of plague into an uninfected place by rats, we will in the present section confine ourselves to the question as to how far rats play an active part in spreading the plague from one village to another.

In view of the facts already recited above and from the analogy of other diseases, it is manifest that there will, in the case of every infected place, in the absence of evidence pointing to the contrary, be a strong presumption that the infection was introduced by man. When, therefore, it is alleged in any particular case that plague has been imported by rats, it would seem necessary to show that plague cannot have been imported either by direct human communication or by means of infected articles. It is obviously impracticable in any given case absolutely to exclude these possibilities, or, in other words, definitely to prove conveyance by rats. It will, however, in any particular case, be reasonable to assume that plague was introduced by rats, if it can be shown that its conveyance by infected articles or by direct human communication is, in the particular case in question, more improbable than the conveyance of the infection by rats. For instance, in cases where there is a presumption that infection has been brought into a village from a particular plague-infected village, and where human communication between the two villages in question can, with probability, be excluded on account of difference of caste or some other circumstance, there will be sufficient reason for considering the importation of plague by rats probable, especially when the two villages in question are situated at no great distance apart, and there is a history of mortality among rats in both, and the rat infection in the village to which plague is imported has preceded the outbreak of the disease there among men.

VII.(2)(*b*).—*Question whether Rats move out from Infected Villages.*

Observations showing that rats may leave a village and travel some distance afield.

235. Before enumerating cases in which plague has been conveyed from one village to another by rats, we may cite a few instances to show that there is a possibility of plague-infected rats travelling some distance afield. We are told, for instance, that in the Sirohi State, when the village of Kalindri was evacuated, dead rats were found in heaps of recently harvested corn collected round a well which was, we understand,
9718-24. about 1½ miles from the village. As a sequel, six of the people camped round the
9860. well and engaged there in the winnowing of the corn were attacked by plague.

A somewhat similar instance came under the observation of Lieutenant Kidd in the
23,012. Belgaum district. Here plague is stated to have been brought out by rats from a village evacuated on the appearance of plague to the people encamped in the fields. So impressed was Lieutenant Kidd with this fact that he thought that evacuation camps should always be placed at some distance from the evacuated village.

A wandering out of rats, similar to that noticed by Lieutenant Kidd, was referred
10,120. to by Captain James, I.M.S. He stated that he had trustworthy information that rats had been seen round a well in an evacuation camp close under the walls of a village.

2116-9. Again, Mr. Westropp mentioned a case in which rats appear to have carried out plague to some houses situated about half-a-mile from an infected village.

VII.(2)(*c*).—*Questions as to Occurrence of General Migration of Rats on Outbreak of Plague among them.*

Observations adduced in favour of theory that rats migrated from the Mandvi quarter in Bombay City.

236. The cases which we have cited above furnish evidence, if such were needed, that individual rats may travel some distance afield from plague-infected places. It has, however, been suggested, and the opinion has been widely held, that a general movement of migration may set in among the rats of an infected place as soon as plague breaks out among them. This theory has come under our notice particularly in connexion with Bombay City, where it was believed that shortly after the outbreak

of plague in the Mandvi quarter the rats of that quarter migrated in a body and dispersed all over the City and beyond it into the neighbouring villages. Plague is said to have broken out everywhere in their train. We are informed that it was ascertained by a series of inquiries that rats entirely disappeared from the quarter of Mandvi, and that they appeared everywhere on the outskirts of the town. It is difficult to know precisely how much weight is to be attached to information collected by such inquiries. But even supposing it were quite trustworthy, this information, would not necessarily plead in favour of the theory that rats migrate when plague breaks out among them. The disappearance of the rats from the Mandvi quarter may have been due to the fact that they had all died out there, while the fact that their presence forced itself upon attention in the outlying quarters of the town may have been due, not to a fresh inroad of rats, but to the fact that rats already present emerged from their holes when they became infected with plague. The only fact which is actually established is that plague attacked the rats of the various quarters of Bombay in regular succession, moving outwards from the Mandvi quarter. Now, this outward spread of plague from an infected centre is, in the case of a human community, regularly brought about, apart from any general movement of the population, by the to and fro movements of the individual members of the community. It would, therefore, not be justifiable to assume, as was done in Bombay, that the outward spread of plague from Mandvi, even it was due to rats, was necessarily the result of a definite movement of migration among these animals.

Snow's Report on Plague in Bombay 1896-7, para. 12.
998, 1168, 1260-1.
Snow's Report, para. 12.
19,247.

Observations made elsewhere than in Bombay City bearing on the question of movements of migration of rats.

Evidence to establish the theory that rats do migrate in a body after plague appears among them must, therefore, be sought elsewhere than in Bombay. Such evidence was carefully sought for by Captain Colomb in the Dharwar district, and by Captain James, I.M.S., in the Punjab. Captain James could find no evidence that rats ever migrated in a body, while Captain Colomb said, "As far as I can make out they never move out of the village." On the other hand, Lieut.-Colonel Adams, I.M.S., and Captain Grant, I.M.S., who had experience of plague in the Sirohi State, seem to have been of opinion that plague was carried from village to village by rats, and the latter told us that "after the epidemic was at its height there was not a rat to be seen in any of the villages." The opinions of these last two witnesses appear to be based upon the observation, already noticed above, that the infection of plague was carried out to a well at Kalindri by rats, and upon the disappearance of rats from villages after plague occurred in them. The former observation, however, does not prove more than the fact, which is substantiated by other evidence also, that isolated rats will leave their homes and occasionally wander afield; and the disappearance of rats from the villages may have been due to the practical extermination by plague of the whole rat population.

10,107.
23,596.
9784.
9904.

Conclusions that theory of general movement of migration among plague infected rats not established.

We think, on a review of the whole of the evidence, that the observations which have been adduced do not in any way support the theory that a general movement of migration sets in among rats when plague breaks out among them. On the contrary, the observations placed on record in a subsequent section of this Report, regarding the enormous numbers of rats found dead day after day in the Mandvi quarter of Bombay, and in the Joria Bazar at Karachi, would seem rather to suggest that the rat population when infected by plague may remain on the spot till exterminated by the disease. Finally, we would note, though it has no direct bearing on the occurrence of migrations among rats when these become infected with plague, that rats swarmed in some of the plague hospitals in Bombay. 21,008-10.

VII. (2) (*d*).—*Cases in which the Introduction of Infection was attributed to Rats.*

Evidence regarding instances in which plague was introduced into villages by rats.

237. We are satisfied that there may in some cases be sufficient intercommunication between the rats of adjoining places to allow of the occasional conveyance of infection by means of rats between such villages, but we think that this can hardly occur except when they are within the range of a few miles of each other. We base this opinion on a general review of the following facts.

Facts observed in the Punjab.

The village of Hamerowal, in the Punjab, was evacuated in consequence of the fact that mortality was noticed among rats. It would appear certain from the careful inquiries which were made that the infection was imported into Hamerowal from the closely-adjoining village of Punian, about 100 yards distant, where also rats had died. The conveyance of infection by human intercourse could in this case be practically excluded, as the inhabitants of the two villages belonged to different classes who had no intercourse whatever with each other. There are thus grounds for imputing the importation in this case to rats, if indeed we are justified in speaking of an importation where the villages concerned were only such a short distance apart.—

10,113.
10,400.

10,109. Another village in the Punjab, said to have been infected by rats, is the village of Chak Kalal. In the case of this village, no history of intercommunication with any of the surrounding infected villages could be traced. Epidemics of plague were, however, occurring among the rats of the villages in question. In view of the careful inquiries that were made in this case, it would seem probable that plague was imported into Chak Kalal by rats.

Observations made by Major Anderson, I.M.S., in the Bombay Presidency.

Other instances of the infection of villages by rats came under the observation of Major Anderson, I.M.S., in the course of his plague duty in the Thana district of the Bombay Presidency. In the group of villages near Bandra, mortality occurred among rats before any mortality occurred among men. Although the histories of the cases are not recorded in sufficient detail to allow of an independent judgment being arrived at as to whether rats did or did not import the disease, it may be of interest 23,210. here to subjoin Major Anderson's statement :—"In Bandra, which is practically a suburb of Bombay, the first local case occurred on 3rd December in a house in which dead rats had been found about one week before, and the disease at once spread in this locality. On the same date another local case occurred in another part of the town in a house where no rats had died. The disease did not spread in this locality, and it is possible that the infection had been caught elsewhere. In Pali dead rats were seen on the 6th or 7th of January, and the first case occurred on 13th January. In Chuim rats died in the beginning of February, and the first case occurred on 9th of February, although it was not reported till the 12th February. In Danda in the same way dead rats were found in several houses prior to the outbreak of the disease on 11th February. The above four villages, separated from each other by a distance of about half-a-mile, are included in the Bandra Municipality. In Santa Cruz, two miles distant from Bandra, dead rats were found on 12th February, and on 15th February the two first cases occurred in the house in which the dead rats were found. In Joo, which is separated from Danda by a creek, dead rats were found in a house about the 10th of April. The people thereupon removed to a shed for 10 days, and then returned to the house, which had not been disinfected, and three days after their return the first occurred in this house. It would appear that the Bandra rats spread the disease in the adjacent villages, as they entirely disappeared from the town, and were only, in the beginning of June, re-appearing. Dead rats were in the same way discovered at an early stage of the local outbreak in the villages of Vela Parla, Andheri, Goregaon, and Padali, which form an almost continuous line of houses along the Bandra-Ghodbandar Road, the intervals between the various villages being at that time filled up by the sheds of Bombay refugees. The disease appears to have been carried along this line of road as it was carried in Bombay itself. In Old Kurla village, which is only separated from New Kurla town by less than half-a-mile of open fields, no case had occurred, though the disease was very prevalent in New Kurla during January, February, and March. On the 4th of April rats died in the house nearest New Kurla, and although that and some of the adjoining houses were vacated and disinfected, the first cases occurred in the village on the 8th April. Here the presumption is that rats came from New Kurla and carried the disease with them." Major Anderson's opinion that the villages were probably infected by rats seems to us to be entitled to the greatest respect, and, indeed, on general grounds alone, it is obvious that an observer who has investigated the matter on the spot is in the best position to arrive at a correct judgment as to the likelihood of plague having been imported by one means or another.

Other observations adduced.

14,377. Of interest also is the case cited by Mr. Petigara in the following words :—"I was on plague duty at a village called Utan, and plague appears to have broken out at Bhaynder. On inquiry into the cause of plague at Bhaynder, no importation of plague from outside could be traced, but dead rats were found at Bhaynder and at a village called Doongri at the same time. There were no plague cases at Doongri, even though dead rats were found, but after the appearance of dead rats at Bhaynder plague cases originated there. The inference drawn was that rats appear to have carried it to Bhaynder, *viâ* Doongri, but plague did not originate at Doongri though it did at Bhaynder," the nearest infected place, viz., Utan, being nearly five miles distant.

There are many other cases of villages on record into which the plague is assumed to have been imported by rats on apparently no better grounds than that the disease broke out among rats before it broke out among human beings, and that no other 14,363. importation of infection had come to light. In particular we have in view such cases as that of the Post Office at Karad. This Post Office is situated near the railway, at a distance of two or three miles from Karad, which was infected with plague. The first circumstance noticed was that rats died at the Post Office : a few days afterwards two cases of plague occurred among the inhabitants. On these grounds the importation of plague was imputed to rats. Similar cases are reported by Lieut.-Colonel Hay from Umbowda Budruk, and Arch. 22,223-30. The mere fact of the occurrence of mortality among rats before the occurrence of mortality among human beings in a village does not, however, suffice to establish the fact that rats were instrumental in importing the infection, for as we shall see below, in many cases the infection was imported by human agency in infected articles, and was communicated by these to the rats. Para. 271 in this Chapter.

Conclusions that rats have in some cases carried plague infection between neighbouring villages.

238. Even after the exclusion of all those cases where the possibility of the introduction of the infection by infected articles or by direct human communication does not appear to have been duly considered, there appears to us to be a residuum of cases in which there is sufficient evidence to make it probable that rats have carried the infection of plague from one village to another situated at no great distance from it.

No facts whatever have come to light which would suggest that plague has in any case been conveyed from one place to another by plague-infected rats carried on railways. Since rats seem to us unlikely to travel in trains, we think that the possibility of plague being spread by infected rats along the railways hardly deserves consideration.

VII.(3).—*Introduction of Infection by Means of Clothes.*

Conveyance of infection by means of clothes.

239. When considering the question of the importation of plague by human communication, we have already seen instances in which travellers from infected places, who did not themselves contract plague, imported the disease into uninfected places, and we have incidentally referred to the likelihood that the infection in these cases was imported in clothes. These cases might, since there is very little opportunity for the infection to be carried on the person as distinguished from the clothing, have been enumerated here. Para. 233 in this Chapter. But we have thought it better to cite here, in our discussion of the importation of infection by means of clothes and personal effects, only those cases in which the importation of infection was specifically imputed to infected clothes.

Instances in which introduction of plague infection attributed to clothes.

The following are instances in point:—A sweeper from Chinkoa, an infected village in the Punjab, worked in Kulewal, in the house of a person who died of plague. The sweeper received as a present some of the patient's clothes. He took these home to his non-infected village and gave some of them to a neighbour. This neighbour was attacked by plague shortly afterwards, and he appears to have been the first 10,747. person who developed plague in Chinkoa. Inquiry did not reveal any other source of infection, except the clothes which had been given to him.—10,394. In Kariam, in the Punjab, the first case occurred in a man who, six weeks before he was attacked, had visited infected villages in which there had been plague three months previously, though not since that time. The man admitted he had brought clothes from these villages, and no other source of infection could be traced. It is stated that the man had not been out of his village for six weeks previous to his attack.—10,082. A woman, a beggar by profession, living at Sotran, in the Punjab, begged from the surrounding villages, including Khankhanan, an infected village, from which she received clothes before the village was cordoned. On the 8th or 9th of March she received some clothes from the house of a sister-in-law, who lived in an infected village. On the 13th of March three or four rats were seen in her house in a dying condition, staggering about as if they were drunk. She was attacked with plague on the 18th of March, and died on the 24th of March. Unfortunately there is no evidence to show that the woman was not exposed to infection between the 8th of March and the 13th of March. Though she was an old woman, and not likely to go far, yet she would hardly follow her profession as a beggar without going into many places and houses.—10,091. At Dahan, in the Punjab, the first case of plague occurred in a house in which property and clothes from an infected village had been deposited on the 12th of February 1898. The first case did not take place till 23 days later, on the 7th of March. A number of dead rats were afterwards found in this and neighbouring houses. A similar case is said to have occurred at 10,093. Parowal.—17,994 Dr. Godinho told us of an instance where a man developed plague in a fatal form in Bombay from using the blanket of his uncle who had a month before succumbed to plague at Lanauli. There was no local source of infection in the house at Bombay in which the case of plague occurred.—15,202-4. Mr. Dhurandhar, an officer of the Baroda State, cited the following instance. Three persons left Bombay to escape from the plague there, and on their way to their village in the Baroda State stopped for three days at Ahmedabad. They left some clothes in the house in which they stopped, and three days after they left that house plague cases occurred in the room which they had occupied. The refugees themselves did not contract plague.—22,024. Mr. Dodgson told us that in 1897 a store-keeper in the camp at Satara went, after the plague had ceased, to live in the village of Kamatpura. A month or two afterwards plague broke out at Kamatpura, and the general opinion was that this man had been stealing the clothes from the dead bodies of women in the camp at Satara, and had given them to his own wife. His wife was the first person who got the plague, and clothes that had belonged to the dead, which he could not account for, were found at his house.—Another similar case, also at Satara, came under the notice of Mr. Ghanekar. 22,527. This was the case of a man employed at the burning place at Satara, who was reported to have taken clothes from dead bodies and given them to his relations. The man himself did not get the plague, but the disease is said to have been carried by the clothes from Satara to a village in its neighbourhood.—20,066. A man took with him to the village of Ladgarh, in the Ratnagiri district, the clothing of his wife who died of plague in Bombay. Shortly after this, three persons in the man's family developed plague. The man himself appears to have remained well.

1,0870—99. A case was reported by Captain Davidson, I.M.S., as having occurred in Multan, a town in the Punjab, remote from any plague-infected place. It appears that a Eurasian female Assistant Surgeon fell ill on the 21st of December 1898. On that date she was suddenly seized with fever and nausea, and within a very short time a painful tumour developed in the left groin. The patient had high fever and headache. The gland began to enlarge, and the pain was so great as to prevent sleep. The patient was seen on the evening of the 24th of December by Captain Davidson, who found that her temperature was $101\frac{1}{2}°$ F., and that there was a great deal of effusion, so much so that the gland could be felt only with difficulty. The fever continued till the 27th of December, when the temperature returned to normal, and after rising again in the evening returned to normal again on the 28th. When fluctuation was detected the bubo was opened and about half an ounce of pus was evacuated. The temperature then finally became normal, the patient being discharged on the 9th of January. Captain Davidson was unable to find any cause other than plague to account for the symptoms, and had no hesitation in diagnosing the case as a genuine case of plague. This diagnosis is entitled to considerable respect from the fact that Captain Davidson had had wide experience of plague. On inquiry it was discovered that the patient obtained all her clothing from Bangalore. In October she obtained three blouses from Bangalore, where plague was then epidemic. She had, however, worn one or more of these blouses for a considerable time before she was attacked. It was stated that plague cases had occurred in the family of the tailor who made the blouses, but there is considerable uncertainty on this point.

Conclusion that plague infection may be imported in clothing.

240. Such cases as those quoted above are not absolutely conclusive as to the conveyance of plague into uninfected places by clothes. In each and all of these cases a doubt may be entertained whether clothes constituted the only possible means of infection. That plague can be conveyed by clothes to distant places is, however, placed entirely beyond the reach of reasonable doubt by the fact that two Goanese stewards, on their arrival in London in September 1896, contracted plague in a fatal form from wearing clothes which they had brought with them from Bombay, and kept in a box until their arrival in England.

Supplement to the 26th Annual Report of the Medical Officer to the Local Government Board, England, 1896-7, pp. 129-38.

VII.(4).—*Introduction of Plague by Means of Merchandise.*

Circumstances of the up-country trade from Bombay.

Paras. 12, 95, 41, 57, 61, and 74 of this Report.

241. We have already seen, in connexion with our discussion in Chapter II. of this Report on the origin of plague epidemics in the larger towns of India, that the suggestion that plague had been imported in articles of merchandise was one of the suggestions brought forward to account for the introduction of the disease into Bombay, Calcutta, Karachi, Hubli, and Bangalore. We saw also that this suggestion was in the case of each of these towns quite unsupported by anything in the nature of positive evidence. At first sight, it might appear astonishing that infection had not been conveyed to many places within India by means of merchandise, inasmuch as Bombay is a distributing centre from which thousands and thousands of tons of merchandise pass inwards to all parts of India. We may, however, in this connexion, again place before ourselves the consideration, already brought forward in the part of our Report which treats of the infectivity of plague, that the goods which are most likely to become infected are food stuffs which have been stored in places to which infected rats may have had access, and rags which may have been infected by plague patients. When we consider the broad features of Indian trade, it will be seen that the merchandise that is distributed from Bombay to other parts of India consists for the most part of imported goods and of textile fabrics manufactured in mills, neither of which are at all likely to be contaminated with plague: and the only item of

Para. 227 of this Report.

merchandise passing up-country from Bombay which might fall under suspicion in connexion with the conveyance of the plague to inland centres are gunny-bags, which are brought into Bombay filled with grain, and returned to the districts empty for refilling.

Gunny-bags suspected of being involved in introduction of infection into Bhujpur.

In addition to the case of Karachi, where, as we have seen, the suggestion that the infection was imported in gunny-bags was quite unsupported by evidence, we find that the suggestion has been made also in the case of the village of Bhujpur in the Cutch State.

The facts concerning the origin of the outbreak in Bhujpur, so far as they were communicated to us, are as follows. The first case of plague in the village was that of a Banniah who traded in gunny-bags, which he imported from Bombay. He fell sick with plague on the 31st of July 1898. On the same day two other Banniahs, who were said to have purchased gunny-bags from him, also fell ill of the disease. There was no plague in the immediate vicinity, the nearest infected place being Cutch Mandvi, some 18 miles distant. It was affirmed that the Banniah who first fell ill had not recently been at Cutch Mandvi. The gunny-bags which he sold must have been imported from Bombay some two months or more previously, as communication with Bombay had been interrupted for that time owing to the prevalence of the monsoon. If the circumstances of this outbreak are correctly reported, we should then have in Bhujpur an instance—and we would note that this is the only reported instance—in which a primâ facie case has been made out tending to incriminate gunny-bags as having been responsible for the importation of plague. But, in view of the fact that the three Banniahs who contracted the disease must have had trade relations with Cutch Mandvi, the possibility of the plague having spread to Bhujpur by means of human communication or of clothes, is not excluded.

13,463—71.

Circumstances of the trade between infected and uninfected districts up-country.

242. Passing now from the consideration of the Bombay trade to the trade which is carried on between infected and uninfected districts up-country, consideration will show that the only trade operations which might fall under suspicion as being possibly involved in the spread of plague are the small operations of trade by which grain is conveyed from an infected to an uninfected village. But such conveyance of grain from one village to an adjacent village is hardly likely to occur apart from direct human communication between the two villages, which, as we have already seen, is chiefly responsible for the spread of plague. For this reason, in most cases, it would be difficult to obtain evidence of the conveyance of infection by grain, even if such conveyance had taken place. As a matter of fact, no case has been brought before us in which the importation of plague into any village has been attributed to grain.

Outbreaks of Mahamari in Kumaun attributed by local opinion to importation of infected grain.

243. We think it, however, interesting to note that in the Kumaun Hills, where, as we gather from Surgeon-General Planck's Report, grain is frequently carried from village to village, the origin of plague epidemics is not infrequently ascribed by local opinion to the importation of grain from infected villages. Surgeon-General Planck inquired into the origin of the outbreaks in 40 villages, and out of the 16 cases of the villages in which any theory could be advanced as to the cause of the outbreak, grain was by the people incriminated in three cases, while in two cases the outbreak was attributed to the importation of grain and ghi, and in the sixth case to the importation of ghi. The only one of these cases which appears to us to be worthy of citation is the following, as narrated by Surgeon-General Planck in his Report :—" Some time in November last, a deaf young man, nephew of Rup Singh, went to Tanda, taking radishes to exchange for rice. The rice he obtained was taken out of the house in Tanda to which a case of gola disease (plague) had been brought from Kausani, as will appear hereafter. The deaf nephew carried the rice to Nainoli, and it was stored in Rup Singh's house. On the 15th January this rice was husked by the women of Rup Singh's house, and it was cooked and eaten by all the members of the family. On the 18th of January, Rup Singh's daughter, aged 12, who had never left the village in her lifetime, was taken ill with symptoms of continued fever, ending in delirium, insensibility, and death on the fourth day. Before she died, a small glandular enlargement was seen in her groin. On the 19th of January, Rup Singh's son, a boy, was taken ill and died on the fourth day also. On the 21st of January, Rup Singh's wife was taken ill and died on the sixth day. And on the 25th of January, Rup Singh's daughter, aged 16, was taken ill and died on the fourth day. The symptoms in all four cases were alike, and bubo was seen in three out of the four cases. After the fourth death occurred, Rup Singh, his third daughter, and the deaf nephew—all the remaining members of the family—hastily vacated the house, and took up their abode in a shed on the northern aspect of the mountain, far from the village site." The other cases referred to in Surgeon-General Planck's Report do not call for special consideration.

App. XXV., paras. 120, 130, 218.
App. XXV., paras. 159, 165, 233.
Vol. II., p. 342, Appendix XXV., para. 130.

VII.(5).—*Concluding Remarks regarding Means by which Infection of Plague is introduced into Uninfected Places.*

Infection conveyed to uninfected places chiefly by travellers.

244. We now proceed to summarise the results of our examination of the evidence bearing on the question as to how the infection of plague is introduced into uninfected places. We see that it has been spread chiefly by the agency of travellers. In many cases these travellers were persons who, having contracted the infection in infected places, sickened of plague when they arrived in uninfected places. In other cases these travellers did not themselves sicken of plague, but carried the infection in their effects and communicated it to persons living in uninfected places who had not themselves been in direct contact with plague cases.

Spread of plague from Bombay has taken place along line of railway and steamship communication, but this spread has been slow.

245. A glance at the maps illustrating the distribution of plague in India (which are printed as an Appendix to this Report) will, in itself, suggest that plague must have been conveyed in this way. That series of maps would seem to indicate that plague spreads along the lines of human communication, and, in particular, along the lines of railways and steamships. Inconsistent with this suggestion would appear to be the circumstance that, though all parts of India are within a very few days' railway or steamship journey of Bombay, plague has, as a matter of fact, spread out only in a very gradual manner in a centrifugal direction from the infected centres, attacking in each successive year a belt of country just beyond the confines of the last infected tract. The combined influences, however, of two circumstances satisfactorily account, in large part, for the fact that the spread of plague outwards from infected centres has been slow. These circumstances are, on the one hand, the fact that owing to the low degree of infectivity of plague in general—a characteristic which has already been demonstrated above—a considerable number of actual importations appear in most cases to occur before plague becomes indigenous in a place, and, on the other hand, the fact that a system of measures was put into force to prevent the travelling of plague-infected persons, and to intercept them *en route* and at their place of arrival, or finally to detect them if they succeeded in effecting an entry.

This slow rate of spread is due, in part, to railway measures. Section IV.(3) of Chapter VI. of this Report.

246. The facts with regard to the number of plague cases stopped while the system of examination on railways was in vogue are dealt with in a subsequent section of this Report, devoted to the consideration of measures adopted to prevent the spread of plague by railway. All that we need say here with regard to the interception of plague patients *en route* will be that one reason why plague has been imported into places near infected centres rather than to places at a distance from such centres is that the incubation period of plague would, in the case of patients proceeding on long journeys, expire before they reached their destination, while this would only rarely occur in the case of persons proceeding on relatively short journeys. Some estimate of the number of incubating patients, who, in the case of towns situated at only a short distance from infected centres, in spite of the precautions taken to intercept them *en route*, had, in the period antecedent to the outbreak of indigenous plague in those towns, succeeded in arriving at their destination, may be formed from the following figures.

12,856. At Poona the first imported cases were detected in October 1896. In December 1896,
12,859. 63 railway passengers from Bombay were discovered at Poona to be suffering from
12,862. plague; it was only at the end of that month that the first indigenous case occurred.
Again, in the period between May 1898 and February 1899, which elapsed between
21,687-8. the end of the second and the commencement of the third epidemic, 30 imported cases
13,906. of plague were discovered at Poona, but no indigenous case occurred.—The case of
Ahmedabad is even more striking. In October 1896 there were 10 imported cases and
two indigenous cases. In the next three months there were 62 further imported cases
of plague detected either at the railway station or in the town, and no further indi-
genous cases arose. In the succeeding four months, in which there were 27 fresh
importations, there were 26 indigenous cases. After this, indigenous plague died out
and the importations became fewer. Only 15 such importations were traced in the
15,556. next 11 months, when only one case of indigenous plague occurred.—The first imported
case detected at Surat was found on the 8th of December 1896. No indigenous case
15,562. of plague was found till the 21st of February 1897. In the interval 32 more imported
15,750. cases had come to light. Again, between March 1898, the date when the second
18,086. outbreak at Surat ceased, and February 1899, 16 imported cases were found, and there
18,088. were no indigenous cases.—About 35 imported cases were discovered in Hyderabad
(Sind), the first in January 1897; the first local case was found at the end of February
12,023. 1897.—At Rohri, in Sind, which is separated from Sukkur only by the Indus, an
12,025. imported case was first detected on the 7th of March 1897. Twenty-two cases im-
ported from Sukkur were detected before a local case of plague was discovered on the
24,225, 24,227. 17th of April.—In 1896, 26 imported cases were found at Ahmednagar. No local case

was reported till the end of October 1897.—At Nasik, according to one witness, 26, and, according to another witness, 35 imported cases of plague came to the notice of the authorities between March 1897, when the first case was detected, and October 1897, when local cases began to occur.—A similar sequence of events was observed at Cutch Mandvi, which communicates by sea with Karachi and Bombay. Between the 3rd of October 1896 and the 28th of February 1897, 47 imported cases were detected in Cutch Mandvi; local cases did not begin to occur till March.

16,966, 14,705.
23,319.
13,360.
13,362.
13,760.

This slow spread is due also to low degree of infectivity of plague.

247. These figures do not differentiate between patients intercepted on arrival and persons found sick in the towns, but since they relate for the most part to persons who were intercepted at railway stations and were then isolated, and practically for the whole of the remainder part to persons whose detection in the towns was promptly followed by measures of isolation and disinfection, the figures given above represent importations which are not likely to have been instrumental in actually spreading plague. These figures, therefore, cannot be legitimately cited as conclusively establishing that a large number of importations did, in the towns in question, occur before the plague established itself in an indigenous manner. They are, however, valuable as affording an indication of the number of plague-infected persons who must have been endeavouring to introduce themselves by railway into the towns in question, not to speak of the many who endeavoured to introduce themselves surreptitiously by road. Even under the most favourable circumstance, it is obviously unlikely that anything like the total of the incubating travellers who got into an uninfected town would be detected. The true number, consequently, of plague cases introduced into towns along the railway in the neighbourhood of Bombay must have far exceeded the numbers of plague patients set down in the official returns as found on the railways or in the towns. The deduction thus seems to us plain that, in addition to the railway arrangements, the comparatively slight infectivity of plague is responsible for the slow rate at which plague has, in spite of the railways, spread outwards from infected centres. It would seem to be the rule for each town in turn to become infected when it becomes so near to an infected centre as to receive from it a very considerable number of incubating patients.

What applies to the spread of plague by means of railways manifestly applies also to towns connected together by means of sea or road communication.

It has been suggested that it is due also to time required for acclimatisation of the bacillus to new conditions.
Section XI.(G) of this Chapter.

248. Before dismissing the consideration of the causes of the slow rate at which plague has spread from infected centres in India, we may notice that some observers have put forward the suggestion that plague cannot be conveyed a long distance per saltum, either by rail or steamship, because the bacillus, in coming from a distant place, is not acclimatised to the new surroundings into which it is introduced. This theory is briefly considered later in this Chapter in connexion with the epidemiological problems which arise in relation to the spread of plague.

In comparison with travellers, all other agencies by which plague may be introduced into uninfected places are unimportant.

249. In comparison with travellers, all other agencies which have been engaged in the distribution of plague from place to place are quite unimportant. Rats, as we have seen, may, in a few isolated instances, have carried the infection, but probably only between closely neighbouring villages. Exceptional also are the cases where clothes, apart from travellers, have carried infection. Quite as exceptional is the origination of an epidemic by the importation of the infection in articles of merchandise.

Report on the outbreak of Plague in the Jullundur and Hoshiarpur districts of the Punjab, 1897-8.

In conclusion, we think that we cannot better summarise the relative importance of the various agencies which have been operative in the spread of plague throughout India than by reviewing in synoptical form the very careful observations collected by Captain James, I.M.S., with reference to the spread of plague in the Punjab. These observations are, in brief summary, as follows:—

Total Number of Villages, out of 91 investigated, where the source of Infection was traced.	Number of Villages into which Infection was imported by Persons who themselves developed Plague after Visits to or Residence in infected Villages.		Number of Villages into which Infection was imported by Persons who themselves developed Plague after coming into contact, in an uninfected Place, with People from an infected Place.		Number of Villages into which Infection was imported in infected Articles.		Number of Villages in which all the Sources of Infection could be excluded, except Rats or infected Clothes.	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
65	42	65	5	8	16	24	2	3

VIII.—SPREAD OF PLAGUE OVER SEA TO COUNTRIES OUTSIDE INDIA.

VIII.(1.) *The Ways in which Infection may be conveyed on Board Ship.*

Spread of plague over sea to countries outside India.

250. In passing now, from the consideration of the means by which plague is imported into uninfected towns and villages in India, to discuss the question of the spread of plague from India to countries over sea, we may begin, before discussing individually the various ways by which plague might be carried over sea, by placing before ourselves as complete a catalogue as possible of the various ways in which the infection might be conveyed on board an outward bound ship.

I. Means by which the infection might be conveyed on board.

The infection of plague might be received on board a ship by the embarkation—

(*a*) of a person who was actually suffering from plague;
(*b*) of a person who, though not sick at the time of embarkation, had already contracted the disease;
(*c*) of plague-infected clothes or other personal effects;
(*d*) of plague-infected merchandise and articles of commerce; and
(*e*) of rats which had previously to their arrival on board contracted the infection of plague.

(*a.*) Measures taken to prevent the sailing from Indian ports of persons suffering from plague have been very effective.
Section IV.(1) of Chapter VI. of this Report.
25,479.

251. In discussing the measures which have been put in force to prevent the spread of plague from India over sea, we shall show that the system of medical inspection of passengers and crews which is carried out on shore previously to embarkation is so carried out as to make it practically impossible for a person who is actually suffering from plague to be received on board. Not only is the system of medical examination directed to stop persons who show overt signs of plague, but it is directed also to the stoppage of all cases of bubo or of fever which may seem in any way suspicious. So much is this the case that out of 25,011 persons, which was the total number of persons prevented from sailing from Bombay to all parts between the 1st of January 1897 and the 15th of March 1899, only 243 persons, or about 1 per cent., were afterwards known to have developed plague. The examination thus is conducted in such a manner as to obviate all danger of the admission on board ships of persons suffering from overt signs of plague.

(*b.*) Impossibility of taking effectual measures against embarkation of incubating persons.

252. On the other hand, no precautions short of placing everybody in quarantine for the full period of incubation before embarkation could possibly prevent the embarkation of persons who were in the earlier incubation stages of plague. Very few persons, however, appear to have embarked at Indian ports in the incubation stage of plague.

Enumeration of the very few cases where persons have embarked in incubation stage of plague on ships bound from India to Europe.

The following isolated cases, which have occurred on board ships proceeding from Bombay to Europe, Aden, and Red Sea ports, appear from the information at our disposal, to have been the only cases admitted while in the incubation period of plague on board ships sailing for these destinations.

Pekin.
752.
Dilwara.
755.
Carthage.
757.
Clyde.
761.
Caledonia.
25,489.

Our list begins with two cases which occurred before the pilgrim traffic from infected ports in India was definitely stopped. These cases occurred on board the *Pekin*, a pilgrim ship, in December 1896, between Bombay and Aden. No further cases developed on board.—Next, we have two cases which occurred on the troopship *Dilwara* in March 1897, before medical inspection was extended to passengers leaving Bombay on troopships. The cases of plague on the *Dilwara* occurred during the voyage between Bombay and Suez. No further cases occurred on board.—Thirdly, we have a case which occurred on board the *Carthage*, a mail steamer. On the 6th of July 1898, four days after starting from Bombay, a native member of the crew was attacked. As we shall see presently, a second case diagnosed as plague afterwards took place on board.—Fourthly, on the 18th of April 1898, a case of plague developed on board the *Clyde* before its arrival at Aden, five days after this ship had sailed from Bombay. No further cases occurred on board.—Fifthly, two cases which were pronounced to be possible cases of plague were taken out from the *Caledonia* at Suez in November 1898.

We have thus, on vessels proceeding from Bombay to Aden, the Red Sea ports, and Europe, eight cases of illness which, in default of exact information, we have reckoned as cases of plague contracted on shore and embarked while incubating the disease. Even supposing the full number of eight to have been genuine cases of plague—and the diagnosis appears, in the cases on board the *Caledonia*, to have been doubtful—these constitute quite a minimal fraction of the passengers who embarked in Bombay for Aden, the Red Sea ports, and Europe. If we exclude from consideration the cases on board the pilgrim ship *Pekin*, which did not fall within the period covered by the figures presently to be cited, and on board the troopship *Dilwara*, whose passengers are not included in the statistics furnished to us by Major Crimmin, I.M.S., Port Health Officer of Bombay, we arrive at the result that out of a total of 132,000 persons examined on sailing from Bombay for Europe, Aden, and the Red Sea ports, between the 1st January 1897 and the 15th March 1899, only four cases of plague occurred.

In addition to the cases mentioned above, a few other plague cases which have to be included in the present category occurred on ships sailing from Bombay and other ports in India for destinations other than Aden, the Red Sea ports, and Europe. Our information regarding these cases is as follows :—

Enumeration of cases of incubating plague embarked on board ships sailing from India to destinations other than the Red Sea ports and Europe.

One case of plague occurred on board each of the ships *Ballarat* and *Bengal*, in August and October 1898 respectively, between their departure from Bombay and
their arrival at Colombo. No further cases occurred on board these ships.—In
nuary 1899 a case of plague occurred on board the *Buldana* bound from Bombay
Rangoon. There appears to be evidence to show that the patient probably
cted the disease on shore.—In July 1899 two cases of plague were found on
he *Dictator* at Suez, the vessel having sailed on the 14th June from Bombay, *viâ*
. This fact was brought to our knowledge unofficially, and we have no accurate
ion as to the source of infection; it is possible that the infection may have
itracted on shore.—A number of cases occurred in December 1898 on board
dara, a vessel which was conveying coolies from Karachi to East Africa.
coolies who developed plague on board appear to have contracted the
ore. One of them fell ill on the day after the ship left Karachi, and
o have contracted the disease within five days after leaving port.
five further cases occurred on board.—A case of which we have
ly through an indirect source is that of the *Annie Maude;* it appears
beginning of March 1897, a fatal case of plague occurred on board
vessel left Calcutta, and two other cases were said to have occurred

Ballarat.
Bengal.
765.
Buldana.
25,491.
Dictator.
Bhundara.
12,250.
25,495-6.
Annie Maude.
26,934.

occasion hereafter to describe the precautions taken at Bombay
to nfected clothing being carried on board by native
rsons ikely to carry the infection. How little,
the risk of plague being carried on board in
ports in India, will be obvious from the fact that
ue broke out in Bo and July 1899, there
ord in whic is said to have

(*c*) Little risk of infection being carried on board ships leaving India by conveyance in infected articles.
Para. 693 of this Report

cases in man on board the ships in which it was being carried, unless possibly indirectly by communicating the infection first to rats. The question whether infected merchandise has been shipped from India is thus a question which can be determined only in an indirect manner, by seeing whether Indian merchandise has ever been instrumental in spreading infection in countries over sea. This will be considered later.

Para. 262 of this Report.

(*e*.) Conveyance of infection on board by embarkation of infected rats.

255. With regard to the suggestion that plague may be conveyed on board by the embarkation of infected rats, we have to note that if this suggestion had any force in it, plague would in 1896, when plague was raging among the rats in the Mandvi quarter, infallibly have been rife on board the ships when lying in or after leaving the Bombay Docks. It, however, appears that no plague cases occurred among men in the ships in the harbour, and that plague mortality among rats was noticed or out-going ships only upon the *Shannon* and the *Patna*, in both which cases, a
already noted, the infection may quite well have been conveyed on board in infecte
clothes or goods. There would thus appear to be no confirmation of the suggesti
that plague may be conveyed on board by the embarkation of plague-infected rats

Para. 252 of this Report.

VIII.(2.) *The Spread of Plague on Board Ships.*

II. The question of the spread of plague on ship-board.

256. Having considered the various ways by which plague may be conve
board, the next question which emerges in connexion with the conveyance o
over sea is the question as to whether the disease shows any tendency t
ship-board. The consideration of this question will best be approached b
review the course of events in the outbreaks of plague enumerated abo
occurred at sea on ships leaving India.

Spread of plague on board ships when incubating patients have been embarked.

On the *Clyde*, the *Ballarat*, the *Bengal*, the *Buldana*, and the *Golconda*,
of plague was limited to the occurrence of a single case. On the *Pekin*
the *Carthage*, the *Caledonia*, and the *Dictator*, the outbreak was in eac
to two cases, and it is to be noted in passing that the diagnosis wa
case of the second patient on board the *Carthage*, as well as in t
patients who suffered on board the *Caledonia*. On b
of plague occurred, and on board the *Bhundara* eig
shows (especially when it is considered that the
the *Bhundara* with coolies) that plague has manife
on ship-board, even in ca here it must have b
elaborate measure and disinfect

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have, therefore, to be considered in connexion with the landing of plague patients. These are, first, the contingency of a patient landing while suffering from pestis ambulans, and, secondly, the contingency of a patient landing while in the incubation stage of plague.

clinical and well characterised plague.

(*b.*) Disembarkation of cases of pestis ambulans.

259. In connexion with the first, it is to be remembered that pestis ambulans is a very exceptional manifestation of plague. It is thus much more likely that cases which are not due to plague will be diagnosed as pestis ambulans, and be referred to a Quarantine Station, than that real cases of pestis ambulans will be allowed to land as unsuspicious. Again, if a real case of pestis ambulans were allowed to land, the risk of the infection being spread by such a case would, as we have seen in discussing the infectivity of pestis ambulans, be very small, inasmuch as in such cases the bacteria neither effect an entrance into the blood stream, nor do they, as a rule, escape from the body in pus from the bubo. In fact, the danger of spread from the landing of cases of pestis ambulans would hardly require consideration, were it not for the fact that, in exceptional instances, cases of mild plague may, owing to a subsequent weakening of the resisting power of the organism, assume a serious form, accompanied by a generalisation of the plague bacillus throughout the body.

Para. 214 of this Report.

(*c.*) Disembarkation of incubating patients.

260. In connexion with the second of the contingencies just referred to, it is to be noted, firstly, that the incubation period of plague does not, as we have shown, exceed five days, and, secondly, that the nearest port of call on the route to Europe from India is, even in the case of mail steamers, five days' sail from Bombay. It will thus be impossible for any person who has contracted plague in India to land in the incubation period, even at the first port of call, much less at any port in Europe. The danger of the introduction of plague into any European country by the landing of a person in the incubation stage of plague may therefore be excluded, unless in a case where the infection has been contracted on board ship. It is not likely that infection should be so contracted, unless in the case of ships in which human plague cases have occurred during the voyage, or on which mortality has been observed among rats. And even here, as will be clear from the fact that plague, as a rule, shows no tendency to spread on ship-board, it is very unlikely that any person would be incubating plague at the time of landing. Even less to be apprehended than the landing of a person in the incubation stage of plague from a ship on which plague cases have occurred among men, or mortality has occurred among rats, is the likelihood of the landing of a person in the incubation stage of plague contracted from infected clothes or personal effects on board a ship on to which infection may have been carried in clothes or personal effects. Such small danger as might be associated with the disembarkation of passengers in the incubation stage of plague seems to us most appropriately dealt with by keeping all passengers who land from ships on which men or rats have suffered from plague under surveillance for a short period after their disembarkation.

Para. 197 of this Report.

(*d.*) Disembarkation of infected clothes.

261. The risk we have just considered, in connexion with the possibility that persons who have come into contact with infected clothes might contract the disease on board and be in the incubation stage of plague at the time of landing, is a risk of the same order as the risk of the direct disembarkation of infective material in infected clothing. Experience, however, shows that this risk is so small as to be practically negligeable, no case being on record of plague being contracted on shore from the landing of infected clothing. The nearest approach to such an event occurred in connexion with the case of the Goanese stewards previously referred to, but it is to be noted that that case occurred before plague was discovered in Bombay, and, therefore, anterior to institution of measures for the prevention of the spread of plague from India. In addition to measures of precaution which are now applied in India, in the enforcement of the disinfection of suspected clothing, it is to be noted that the sanitary regulations of many European countries prescribe the disinfection of all personal linen on board all ships before arrival from infected ports.

Para. 240 of this Report.

(*e.*) Disembarkation of infected merchandise.

262. The question of the possibility of plague being carried into countries over sea by infected merchandise is a very wide question, affecting as it does the general operations of trade It would seem to us that the most important point to consider with regard to this question is the fact that, though plague might conceivably be conveyed in this manner, millions of tons of Indian merchandise have been imported into the great European ports, without giving origin to any outbreak of plague, either among the stevedores who handled the cargoes in bulk, or among the operatives who dealt in detail with the merchandise. The event has in these cases conclusively

Para. 659 of this Report.

confirmed the anticipations based on the bacteriological observation that, in the case of merchandise which has been artificially infected by plague cultures, the plague bacillus is rapidly destroyed by desiccation. On the other hand, it would not be legitimate to take our stand on the fact that the introduction of infection into countries over sea has in no case been brought home to merchandise. It would, in other words, not be legitimate to argue, from the non-occurrence of any outbreak directly traceable to merchandise that the introduction of infection in merchandise is impossible. On the contrary, a general survey of the facts relating to the outbreak of plague in Europe and other countries outside India, indicates that the introduction of plague infection during the last two years may, in a number of places, have taken place altogether independently of the landing of any plague-infected patient or his effects—we may instance the cases of Madagascar, Oporto, Sydney, and Glasgow, in 1898 and 1900. In other cases it is plain that the human plague patient who was discovered ill of plague contracted the disease from infective material carried on board—we may instance the cases of plague which were found in South Wales and in Hamburg in 1900. It is difficult to explain these importations in any other way than by supposing that merchandise may, under some unknown, and happily rarely realised, conditions, retain the infection for prolonged periods.

IX.—AGENCIES BY WHICH PLAGUE IS DISSEMINATED WITHIN THE LIMITS OF AN INFECTED PLACE.

IX.(1.) *Spread of Plague in infected Places by Human Agency.*

Importance of human agency in spreading plague within infected places.
Section VI. of this Chapter.
Section VII. of this Chapter.

263. We have already, in the portion of our Report which deals with the infectivity of plague, seen that a man can contract the infection of plague—(i) by coming into contact with plague patients (and patients who are suffering from the pneumonic form of plague, or who are in the last stages of bubonic plague, are those whose infectivity comes specially into consideration here), (ii) by coming into contact with infected rats, (iii) by coming into contact with clothes and other infected articles, and (iv), lastly— and this would appear to be the commonest source of infection—by visiting, or residing, in a house which has been infected either by men or rats. Again, in the section of our Report in which we have dealt with the various agencies by which plague may be imported into uninfected places over land, we have seen that man himself must be regarded as an agent of predominant importance in the distribution of the infection of plague, and that infection has been carried about from village to village and from town to town pre-eminently by persons who have themselves contracted the infection, or, who, failing that, have carried back with them infected articles. It will not be necessary, therefore, in this section to labour either the general point that man must be an important agent also in carrying about plague within the limits of an infected place, or to establish by a series of specific instances that within the limits of towns and villages the infection has been carried about in connexion with visits paid to plague patients, in connexion with attendance at plague funerals which may involve, among other things, contact with the corpse, and in connexion with visits to infected houses in which plague has occurred either among men or among rats. We may, however, briefly advert here to a few incidental facts which bear upon the points to which we have just referred.

Spread of plague by attendance on funerals.

264. In illustration of the spread of plague in connexion with attendance at funerals, we may consider the following histories.

9702-9.
9796-802.
9764.
Paras. 202-3 of this Report.
II. 538.
24,441.

The infection was brought to the Sirohi State by a Banniah from Poona. He died the day after his arrival. A largely attended funeral feast was given and the clothes of the deceased man were distributed. As a sequel, twenty-six cases of plague occurred within six weeks of the funeral feast in the village to which the deceased came and in three other villages within two miles of it. All these cases occurred among Banniahs. The somewhat similar cases which occurred in the village of Gungaur, and in connexion with outbreaks of pneumonic plague at Backergunge and elsewhere, have been cited above in our discussion of the infectivity of that form of disease. In the case of Calcutta, Dr. Justice noted that "funerals are powerful factors in spreading the disease among the neighbours." Mr. Moore said that in the evacuation camps at Surat, if any one died, "his caste people came and sat round him and lamented and accompanied the corpse to the burning pyre," with the result that plague was kept alive in the camps. He also stated that plague was kept alive in the camps because people went out and "used to hire themselves out as plague corpse bearers." 24,422.

Spread of plague by death ceremonies in India. 17,993.

265. Closely connected with the dangers of attending funerals, are those which are incident to death ceremonies in India. These are described by Dr. Godinho, one of the Assistant Health Officers of Bombay, as follows:—"So far as the Hindus are concerned, they have got special ceremonies which the female kind undertake. First they make an ablution, and then afterwards put some stuff into their mouths and noses and other orifices. Muhammadans close the different orifices by a plug of cotton, camphor, and spices: a rupee or some coin is placed in the mouth; afterwards this is taken off and replaced; and I have seen the womankind suffering from plague through handling these coins."

Spread of plague by therapeutic ceremonies and native medical treatment. 10,104.

266. The practice of certain therapeutic ceremonies would also appear to conduce directly to the spread of plague. We hear of women in the Punjab, in order to take the pain away, making passes over and touching with their clothes the buboes of infected persons. A ceremony such as this might, owing to the possibility of contamination with the excretions of the patients, conduce to the spread of plague. A similar sort of danger would seem to exist in connexion with the circumstance that barbers practice as surgeons, this practice being rendered dangerous not only by the fact that the healthy are thus placed in communication with the 10,051. sick by the intermediary of the barber himself, but also by the fact that the plague 17,962. may be spread by means of the razors which, after use for opening plague buboes, are, III. 44. without previous disinfection, used for shaving uninfected persons. It has been suggested that similar danger may arise in connexion with the carrying about of 9253. leeches from plague patients to persons suffering from other diseases. 22,287. In the case of Bilron in the Punjab, it appears that the original infection and the re-infection of the village was traced to visits made to plague patients with a view to applying leeches. Captain James' Report, pp. 85, 90.

IX.(2.) *Spread of Plague in infected Places by Clothes.*

Spread of plague by means of infected clothes.

267. We may pass now to the spread of plague within the limits of an infected place by clothes.

In this connexion we might refer to particular instances, such as the case cited by Captain Leumann, I.M.S., in which plague broke out in a number of successive families 3121. who came into possession of a particular set of infected clothes. We might further refer to the case narrated by Captain Chaytor-White, I.M.S., where plague broke out in a camp in the neighbourhood of Kankhal in the person of a man who opened a box 9483. of clothing which had been removed from that town. Other similar cases might be 23,957. referred to. But isolated instances such as these do not throw much light upon the question as to the spread of plague by means of clothing, more especially as the possibility of the infection being otherwise contracted could not in any of these cases be satisfactorily excluded.

More conclusive with regard to the rôle played by clothing in the distribution of plague in an infected place are the opinions formed by certain experienced plague officers. Of these it will suffice to quote the following:—Mr. Winter, who directed 8780. the plague operations in Hardwar, Kankhal, and Jawalapur, had noticed that "the 9256. people removed their clothing from the houses in which cases had occurred, or from adjoining houses, to other parts of the town at Kankhal, with the result that fresh cases sprung up in different parts of the town, whereas at Jawalapur, where our measures made it less easy to so remove the clothes, the spread of plague was more easily checked."—Mr. Moore, who directed the plague operations in Surat, said, 24,393. "people, when they are ordered to bring out their kit and to have it disinfected, or in a case of clothes belonging to the patient to have them burnt, often conceal a part, and it is smuggled off by a friend or neighbour, and the friend or neighbour by so doing takes plague to his own house."

IX.(3.) *Spread of Plague in infected Places by Merchandise.*

Influence of merchandise in the spread of plague within infected places.

268. We have already seen, in connexion with the infectivity of articles of merchandise and the part played by merchandise in carrying plague to uninfected places, that foodstuffs and other articles of merchandise may be infective, and that in a few cases there is reason to suspect that they have originated attacks of plague. No facts have been adduced to show that within an infected place there has been any spread of Paras. 227 and 241–3 of this Report.

plague by means of infected foodstuffs or other infected merchandise. On the other hand, Mr. Giles, the Commissioner in Sind, in reply to a question as to what were, in his opinion, the chief modes of the dissemination of plague, after having referred to 11,278. the predominant influence of rats and clothes, said : "Then there is something in the retail grain shops, the nature of which is uncertain. I do not, for a moment, say that the grain gives the infection, but the Banniahs' shops, where the grain is sold, and the flour mills, are dangerous places. That infection is spread by these grain-sellers, I think there is no doubt about at all. It kept on recurring among them." 11,430. Lieut.-Col. McCloghry, I.M.S., was of the same opinion. He said : "The petty dealer purchases his stores in bulk from infected godowns or shops . . . . and with them infects his own dwelling and the rats therein. The rats in neighbouring houses frequent his shop for food, and also become infected and spread the germs. Thus, there is a spread of the epidemic by a material brought from infected quarters. What the material is I cannot suggest."

IX.(4.) *Spread of Plague in infected Places by Rats.*

Facts illustrating severity of epidemics among rats.

269. We pass now to consider the influence of rats in the distribution of plague within the limits of an infected place. It will be convenient to commence by setting forth certain facts with regard to the severity of plague epidemics which have occurred among rats in certain places.

22,646. Lieut. Anderson, speaking of the second epidemic in the Joria Bazar of Karachi, told us that as many as 105 dead rats were found in one house ; in two other houses he spoke of having found as many as 75 and 65 dead rats. With reference to the same epidemic, Mr. Giles spoke of the number of dead rats as an extraordinary sight : 11,198–205. "I used to go down every morning, and morning after morning you came to the same godown, and perhaps one morning there would be 10 dead rats lying on the ground, another morning there would be 11, and so on continuously ; although the godown had been swept out and disinfected, yet the very next morning there would be a lot more dead rats on the ground. In the bags full of grain and other material, you would see the rats popping out of the bags and running in every direction and scuttling across the street by you. . . . In one house that Lieut. Anderson visited, from which the people had been cleared out about six weeks, you really could not take a step without treading on a dead rat. . . . On the staircase of that house, on one step there would be two dead rats ; on the next, one ; and on the next two dead rats ; and so on the whole way up. You could not tread on the floor without treading on a dead rat."—The rat mortality in the Mandvi quarter, at the outbreak in 1896 of the first epidemic in Bombay City, appears to have been on a similar scale, it being 8704. possible, as Mr. Hankin told us, to pick up "bucketfuls of dead rats every morning in the infected quarter of the town at the commencement of the epidemic." 14,437. "To give an example," said Professor Muller, "of the abundance of dead rats, when Mr. Hankin arrived he drove down to Mandvi and asked for some dead rats. In five minutes I got him twenty in and around the houses in Dongri Street. He said he wanted some freshly killed rats. I went into a house and turned over some bales. Rats ran out in all directions, and I pursued and killed some with my riding-whip. They were all sick. I noticed rats on the Masjid Bandar Bridge running about as if they were drunk ; you could see them lying about the streets in quantities. I have never in any part of the town seen sick, dead, and dying rats in such quantities. Mandvi being the centre of the grain godowns (stores), there are perhaps more rats there than 2269. anywhere else."—The mortality among rats in Sukkur also is said to have been "fearful" ; we are told that in a particular temple 35 dead rats were found.—In a 3117. particular period of the epidemic in Hubli the mortality among rats was on a very large scale ; hundreds of rats were found dead in a goods shed of which the floor was 22,125. taken up.—"In one of the worst infected quarters of Bhiwandi," said Lieut.-Col. Hay, "I remarked a bad smell emanating from a shop which had been closed for two months. I forced the door open, and on entering discovered several dead rats. One rat was actually dying. It was crawling across the floor, and I killed it with a stick. I ordered the rat holes to be opened up, and I discovered no less than 57 dead rats in various stages of decomposition. Some of them were skeletons. They had burrowed into the walls and into the floors. Plague was raging on all sides of this shop, which apparently was the centre of infection from which the disease radiated. It seemed to be the exact centre, as plague was very bad all round there."

Bacteriological observations made in connexion with above epidemics.

270. A few isolated bacteriological examinations were made in connexion with the rat epidemics referred to above. Dr. Gibson, in the case of the epidemic in the Joria

Bazar at Karachi, examined a few "mummied" rats, but this was months after the epidemic had taken place; as might have been expected, the results of these belated observations were purely negative. In the case of the rats found dead at Hubli, Captain Leumann, I.M.S., found typical plague bacteria. The fact that the rats that died in Bombay City died of plague was frequently verified by bacteriological observation, in the different epidemics, by many observers, including ourselves. The only systematic series of observations, however, on rats found dead in Bombay is a series of 18 observations placed on record by the Austrian Plague Commission. Of the 18 rats examined, 16 came from the Mandvi quarter, and the two others from other parts of the City. Of the 16 Mandvi rats, in eight it was ascertained with certainty that death was due to plague; in six others, owing to their having been received in a putrid condition, definite conclusions could not be arrived at; in one case death was due to tuberculosis; and the last of the 16 had died from violence. The two rats obtained from other parts of the City had both died of tuberculosis.

11,21?. 3117. 8705. Report of the Austrian Plague Commission, II. C. 693.

Question as to how long after importation of infection rats are affected and whether before or after men.

271. The next question, which we have to consider in connexion with the spread of plague by rats, is the question as to how soon after the importation of infection an epidemic among rats breaks out, and, in particular, the question as to whether the rat epidemic precedes or follows upon the spread of the disease to men. In this connexion the following cases may be considered.

Specific instances bearing on the question.

In the village of Sotran, in the Punjab, referred to above as an example of a village which was infected by the importation of clothes, rats were found in a dying condition, staggering about as if drunk, five days after the incriminated clothes reached the village. The first human cases occurred five days after diseased rats had first come under observation.—In Baroda, as we were told by Mr. K. B. Jadhav, when a locality known as Dave Mola "was evacuated at the end of March, three boxes of clothes and other kit were taken to a house in Anawala Mola. After about a fortnight dead rats were found in that house, and two or three people died of plague."—At Ladghar, in the Ratnagiri district, also previously referred to as a village which was infected by clothes, rats are said to have begun to die two or three days after the infection was brought to the village. Human cases did not occur till later.—In the case of Khandwa, in the Central Provinces, plague was imported by a traveller from Bombay who fell ill of plague seven days after his arrival. Three dead rats were found in his house within about 12 days of his arrival, the first being found two days after his death. Three days after the first dead rat was observed, a boy, who lived in the verandah of the house, fell ill of plague.—At Nasik dead rats were found three days before an indigenous case was reported.—At Ghoti, in the neighbourhood of Nasik, three or four dozen rats were found in a house in which the first imported case occurred. Dead rats were found scattered over the village before the next human case occurred.—At Bulsar dead rats were discovered about 12 days after the importation of the infection. A week subsequent to this a human case occurred.—In the village of Umbowda Budruk, in the Satara district, dead rats were found seven days before plague cases occurred among men.—In Agashi, Kelwa, Marol, Jegapur, Bandra, Pali, Chuim, Danda, Santa Cruz, and Old Kurla—all villages which came under the observation of Major Anderson, I.M.S.—mortality among rats in each case preceded the occurrence of plague cases among men. In many of these cases the dead rats were found within two to five days after the infection had been imported by human agency. The human cases which occurred subsequently appear, so far as the records enable us to judge, to have occurred generally within two to five days afterwards.

Para. 239 of this Report. 10,082. 15,170. 20,066-73. Para. 239 of this Report. 5958-61. 14,705. 14,695. 16,164 22,223. 23,207. 23,216.

Opinions of plague officers on above question. Paragragh 275 of this Report.

In addition to the specific instances quoted above, and those quoted later in this section of our Report in the consideration of the dissemination of plague by rats broadcast through villages, we have the general experience of a number of plague officers, who were engaged in plague duties in villages scattered over many of the infected districts. In the opinion of these officers—and we may particularly mention
holding this opinion Khan Bahadur Bomanji Edalji Modi, Mr. Durandhar, Colonel 14,072-8, 15,199,
I.M.S.. Mr. Shepherd, Mr. Monteith, Lieutenant Steen, Mr. Carmichael, 18,107, 18,792,
—mortality among rats generally precedes the occurrence of 19,650, 22,694,
Each of these officers, however, had met with instances 22,922, 24,044
among the human inhabitants, while it occurred in

lear both from the specific instances cited above and
oted, that plague, in many instances, breaks
human community.

Human epidemics not necessarily associated with rat epidemics.
Annales de l'Institut Pasteur, October 1898.
Para. 220 of the Report.

272. An epidemic of plague among rats does not, however, as certain witnesses who appeared before us, and M. Simond, in a paper already referred to, have assumed, in every case precede and lead up to an epidemic among men. There are, on the one hand, many instances of severe plague epidemics among men occurring independently of the outbreak of any epidemic among rats, and there are, on the other hand, as we have seen in discussing the infectivity of plague-infected rats, isolated instances of epidemics which have not been followed by plague cases among men.

Instances of epidemics unaccompanied by death of rats.
21,723-4; 15,886; 16,964, 16,998; 13,153-5; 24,090, 24,276-7; 13,929; 12,057; 9,675; 13,461.

Instances of human epidemics which have been unaccompanied by noticeable rat epidemics are the first and second epidemics in Poona and the epidemics which occurred in Surat, Nasik, Palanpur City, Ahmednagar, Ahmedabad, Rohri, Khandraoni, Cutch Mandvi, and the Cutch State generally. We cannot do better than quote in this connexion the evidence of Major Hyde-Cates, the Political Agent of the Cutch State, in reply to a question as to whether he had heard much of mortality among rats, he said :—" No. They have had dead rats in Bhadresir on two separate occasions. The houses in which these dead rats were found were treated as infected houses. No epidemic followed this death rate amongst rats, and the place has only had four indigenous cases since plague came into Cutch. Though I have daily visited the town of Mandvi for months during the two epidemics, and visited hundreds of infected houses, both before the disinfecting parties came to them and during the process of disinfection, I have come across very few dead rats, and have been particularly struck by it. I think I could safely say that I have not seen more than a dozen. At Patri, Bhujpur, and one or two other villages, dead rats have been found prior to an epidemic, but I have never received any report of what might be called an epidemic amongst rats." The epidemic in Cutch Mandvi, to which Major Hyde-Cates refers, was one of the most severe which occurred in India, and among the other epidemics which we have cited above there are several of considerable severity,—noticeably those which occurred in Poona. We may, in this connexion, refer to the fact that in only nine out of a total of forty village epidemics, which are detailed by Surgeon-General Planck in his report on plague in Kumaun and Garhwal, was a history of plague among rats obtained.

II., 361, para. 259.

Instances of epidemics unaccompanied by death of rats succeeded by second epidemic in which rats died.
11,202.
23,067-9.
10,127.

Again, in places other than those we have just mentioned, plague has broken out among rats only in connexion with a second human epidemic, while it has not been noticeable in connexion with the first human epidemic. This, for instance, was the case in Karachi, where mortality was not noticed among rats until the commencement of the second epidemic among men. Belgaum is another instance in point; there the first epidemic among men in October 1897 appears to have run its course without spreading to the rats; in the second and severer epidemic in May 1898 there was a concurrent epidemic among rats. Similarly, in the plague-infected villages in the Punjab there was in the autumn of 1897 very little evidence of the occurrence of the disease among rats; in the spring of 1898, on the contrary, there was overwhelming evidence of rats dying in every direction.

We can hardly suppose that the absence of noticeable mortality among rats in a large proportion of urban and village epidemics can be attributable to an absence or paucity of rats in the localities in question, and it is one of the as yet unsolved problems, in connexion with the epidemiology of plague, why the disease has spread in different degrees among rats in different localities and different seasons.

Influence exerted by rats on dissemination of plague within infected places. Observations made in totally evacuated villages.

273. We may now pass on from these preliminary questions to consider the influence which is exerted by the breaking out of the disease among rats upon the local dissemination of plague within an infected place and upon the severity of the human epidemic. For the most valuable information on the first of these questions we must have recourse to observations made in evacuated villages, where, since the factor of human agency falls away, we are in a position to determine with some approximation to accuracy how far rats are responsible for carrying about infection from house to house.

Case of Mahlgahla.
9987; 10,348.

Of particular interest in this connexion are the events which occurred at Mahlgahla
one of the infected villages in the Punjab. The inhabitants of Mahlgahla, some
in number, were placed in camp by Captain James, I.M.S., on acc
of plague which was confined to one special quarter of the villa
been disinfected without incident, the disinfection of t
was taken in hand. In the absence of other availa
here employed upon the disinfection of their own hou
to work they came upon dead rats all over the village
these were found in a single room. Five da
disinfecting the houses which had been

evacuated numerous cases of plague began to occur among the disinfectors. So severe was the outbreak of plague among these (the resulting epidemic did not subside till 75 persons in all had been attacked) that the disinfection operations had to be suspended. The quarter of the village in which most of the disinfectors were attacked was the quarter most remote from that in which the original group of plague cases had occurred.

Case of Chak Kalal.
10,110.

Equally instructive are the events which occurred in the village of Chak Kalal, a small village which, while it was still free from plague, was described as an island in the middle of a sea of plague. This village was evacuated as a precautionary measure. A few days afterwards, owing to the downpour of rain, a considerable number of the inhabitants returned to their houses. A number of rats (and these were shown by bacteriological examination to have died of plague) were found lying dead all over the village. Within a few days afterwards, quite a considerable number of people contracted plague. It seems clear that the infection was here disseminated over the whole village as a result of the outbreak of plague in an epidemic form among rats.

Cases of other villages in the Punjab and in Bombay Presidency.
10,143-52.

What occurred in these villages on a large scale appears also to have occurred on a smaller scale in several other villages in the Punjab. In Khankhanan, we are told, the disinfectors contracted plague in a portion of the village which was not known to be infected at the date of evacuation. The dissemination of the infection beyond the limits of the originally infected quarter of the village was by Captain James imputed to the agency of rats. Captain James thought he had presumptive evidence of a similar conveyance of plague from place to place in an infected site also in the cases of the villages of Mallupota, Bahrwal, and Kariha. Mr. Dodgson, the Collector 22,065.
of Satara, observed a similar spread of infection in an evacuated village, and he was convinced that it was due to the agency of rats. "You can," he said, "take a village with a few infected houses at one end, or in one quarter, and turn all the people out, and you will constantly find that when the people go back to the other end of the village, or to a hitherto uninfected quarter, and sleep there they got the plague." Lastly, Major Anderson's experience led him to a very similar conclusion. He cited 23,215-24.
in particular the case of a village called Hunsikatti, which he evacuated as a precautionary measure, in consequence of a few dead rats being found there. No cases occurred among the people in camp until three weeks afterwards. Two cases of plague then occurred. It was probable that the patients had visited their houses and contracted the infection there, for on inspecting the houses in the village it was found that seals which had been placed upon the houses of these two persons had been tampered with. In view of the fact that these houses were probably not infected at the time when the village was evacuated, it seemed likely that plague had been conveyed to them by the agency of rats during the absence of the people in camp.

Proof of spread by rats derived from consideration of course of plague in partially evacuated places.

274. So far we have dealt only with the case of a completely evacuated village, where, since the spread of plague through human agency may be excluded, the conveyance of the infective material from place to place can be imputed only to rats; for we may practically leave out of consideration such remote contingencies as its conveyance by means of carnivorous animals, or birds of prey, or the agency of the wind. We now pass to follow the course of events in the case of places which were only partially evacuated. In this connexion the history of the spread of plague at Banga in the Punjab is instructive, as showing the influence which rats may exert on the spread of plague under such circumstances.

Case of Banga.
10,235.
10,256.

Banga is a small town of some 5,000 inhabitants, where, with a view to the detection of the first case, corpse inspection was regularly carried out. As soon as the first case was detected, a brick wall, some eight feet high, was built across the street of the "muhalla" or quarter where the case occurred. The inhabitants of the quarter, 87 in number, were, so as to avoid all contact with the other inhabitants, taken out through an opening specially made in the town wall, a guard being placed on that opening, so as to prevent entrance into the evacuated quarter. The evicted people were taken some distance outside the walls, and a cordon was placed round their camp. Seventeen days after this evacuation had taken place (and at this date the evacuated people were quite free from plague) three further cases of plague were discovered in two houses situated just outside the evacuated quarter, one on either side of it. On the day on which these cases were detected a dead rat was found in one of the houses in question, and a day or two before a dead rat had been seen by the disinfectors when at work in the evacuated quarter. On the discovery of these three cases the 203 inhabitants of the second quarter were evicted. They, too, were taken out through an opening specially made in the town wall. At the same time the four adits by which the newly infected quarter could be approached from the town were sealed up by brick walls, a guard being placed upon them and upon the opening in the town wall by which the people had been removed. Thirteen cases of plague developed in camp among the 203 inhabitants who were removed from the second quarter. Ten days after the date of this second evacuation, another case of plague occurred in the town just beyond the boundary of the second evacuated quarter. Immediately, the inhabitants of this third quarter, numbering in all some 249, were removed and placed in camp. The adits to this newly infected quarter were bricked up in the same way as had been done in the case of the other quarters. Four more cases of plague developed among the people who had been removed from the third quarter. After this third evacuation there was another interval of nine days, during which no plague cases were found in the town. Two further cases were then found, and on the next day three more, two of these being in a house which a sick rat had been seen to enter. After this dead rats and plague cases were found all over Banga, and the town was completely evacuated.

Instances in which rats spread plague broadcast in villages.

275. The dissemination of plague by rats, which is so clearly brought out in the
cases of Mahlgahla, Chak Kalal, and Banga, cannot be so clearly followed in places
which were not evacuated. There are, however, many instances on record of villages
22,934. where, after an introduction of plague, rats became infected, with the result that the
infection was distributed broadcast through the village. In illustration of this we may
cite the following cases :—"In Jegapur, a village in the Dharwar district, a man,"
Major Anderson, I.M.S., told us, "went to visit his brother's wife, who was suffering from
23,207. plague at Shelawdi, nine miles distant. Two or three days after his return rats died
in his house, and three days after his daughter was attacked by plague and died.
Rats also died in the adjoining houses shortly after the girl fell sick, and 29 cases
5048-62. occurred in the village, which was promptly evacuated."—The village of Guntakal was
infected by a woman who died of plague there. After her death her house was shut
up for three weeks, no one venturing near it. After that time plague cases began to
occur among the inhabitants of the village. A large mortality among rats was reported
between the first case and the subsequent cases, and dead rats were found in almost
4167, 5097. every house inspected after the disease had spread among the villagers.—In Kotala,
a small village near Guntakal, the three first plague deaths occurred in one house;
the patients belonged to a caste with which the rest of the villagers would hold no
communication. Immediately upon the third death the house was burned down. After
an interval of 15 days or 3 weeks, a further case of plague occurred, and it was
reported that rats were dying in the village. Subsequently to this, an epidemic broke
13,399-401. out in the village, there being nine attacks in one day.—In the case of Mundra, a town
of 10,000 inhabitants in the Cutch State, the importation of 26 cases in nearly
four months was accompanied by the occurrence of only 17 cases of indigenous plague.
The town was then free from plague for two and a half months. After this the
plague reappeared, four indigenous cases occurring on one day, and the reappearance
of the disease being preceded by the death of numbers of rats. During the next
22,223. four months there were close on 500 attacks of plague.—In the village of Areh, after
the discovery on the 1st and 2nd of October of dead rats in two houses, nine persons,
on the 3rd of October, were attacked by plague in the houses in question and the
houses adjoining them.—In Kausani, a Kumaun village, where an outbreak of
mahamari in 1876 was investigated by Surgeon-General Planck, rats were found
II. 347. dead in every hut of a range containing eight huts. Some days after, plague broke
out among the inhabitants of these huts, and of these inhabitants, who numbered in
all about 13, five sickened all about the same time.

Opinions of plague officers regarding influence of rats in disseminating plague.

276. With regard to the influence exerted by rats on the course of plague in towns and cities, the general tenour of the evidence which we have collected may be judged from what was told us by the following officers who were engaged in plague operations :—

1002, 1168. Lieut.-Col. Weir, I.M.S., the Health Officer of Bombay City, and Mr. Godinho,
18,004. one of the Deputy Health Officers, repeatedly observed that the death of rats in a
8288, 10,961. district preceded an outbreak of plague among the human inhabitants. Captain
25,795. Bingley, Major Ross, and Lieut. Firth had observed a similar sequence of events.

11,313. Mr. Giles, who directed the plague operations in Karachi, said :—"Almost always
dead rats appeared before the plague. The Superintendents themselves generally
11,835-7. saw rats before they had cases." Mr. Kaka, the Health Officer of Karachi, referring
to dead rats, said :—"I have seen them generally precede an outbreak in a house."

Lieut. Anderson, also speaking of the Karachi outbreak, said:—"In the market 22,646.
quarter the spread of the disease was extremely rapid, and was, I believe, conveyed
entirely by rats, dead ones being found in almost every house in the quarter." The
experience of Lieut. Law, who was also employed in Karachi, was similar to that of 11,974.
the officers just quoted.

Mr. Madhava Rau told us of Bangalore, that when plague got into "the principal 3242.
grain mart of the City, rats became an important factor in the dissemination of the
disease . . . rats being found as many as 10 in a house, immediately followed by
plague attacks."

Summary regarding influence exerted by rats in disseminating plague.

277. It is unnecessary to make further quotations from the evidence, which seems to us to be conclusive, that rats in some places, but by no means in all, have been active agents in the dissemination of plague. It has been clearly established that when the infection of plague has been imported into a town or village rats have, in many cases, contracted the infection before any indigenous cases occurred among men. Again it has been clearly established that, when rats have become infected, they have been instrumental in spreading plague in evacuated villages, and in carrying the infection outwards from evacuated quarters. Hardly less clear is it that rats have been frequently at work in disseminating the infection of plague in inhabited towns and villages, and that in some cases they have been responsible for the occurrence of an explosive outbreak of plague among men. It is, however, important to note that the outbreak of plague among rats has not in all cases been followed by the occurrence of plague among men, and that explosive outbreaks have sometimes been due to causes other than the spread of the infection by rats.

IX.(5.) *Spread of Plague in Infected Places by Animals other than Rats.*

Dissemination of plague by means of animals other than rats.

278. Among the animals which are eminently susceptible to plague and liable to contract the disease in their wild state must, as already mentioned incidentally, be reckoned not only rats, but mice, squirrels, and monkeys. It is important, therefore, to consider here what influence these animals may have in the dissemination of the infection of plague.

Mice.

With reference to mice, it is to be noted that laboratory experiments have shown
that these animals are exceedingly susceptible to plague, succumbing when even 26,323.
minimal doses are injected under the skin. Mice may be infected by the mouth also, our 8677.
experience in this matter, though differing from that of the German Plague Commission, 26,324.
being in agreement with that of the Austrian Plague Commission. In spite, however, Report of German Plague Commission, pp. 255–6.
of their great susceptibility to plague which is testified to by laboratory experiments,
the instances in which deaths among mice are recorded in connexion with plague epidemics Report of Austrian Plague Commission, II. C. p. 701.
are rare. Lieut.-Colonel Weir, I.M.S., told us that he knew only of one case in Bombay
in which mortality had been observed among mice, viz., in the Pydhownie Police Office
in Bombay. Unfortunately the mice which were found dead in this place were not 908.
bacteriologically examined, and it was not conclusively proved that they had died of
plague. Dr. Shrinivasa Rau informed us that in Bangalore many mice died from 3594–5.
plague, and that he had himself dissected 10 mice which had died from the disease.
In Porbandar more mice than rats were found dead during the epidemic of plague, 13,699–700.
and in two localities the death of mice was reported before any case occurred among
human beings. In Timmencherla dead mice were found during the plague epidemic. 5047.
In Karachi, where, as we are told, there was only a small mortality among mice,
the conveyance of the infection was in a particular instance traced to mice. The case 11,422–6.
in question was that of an old woman who was not in the habit of going out, and
who developed plague four days after dead mice were found in her house, this last
being at some distance from the parts of the town which were at that time infected.
The above would seem to be the only case where the conveyance of plague to man was
directly traced to mice.

Squirrels.

279. With regard to the occurrence of plague among squirrels, we ascertained that 3116; 2601, 2654
mortality among these animals was observed in Hubli, in Bangalore, in Poona, in 3597; 21,295;
Baroda, in the Kaira district, in Ankleshwar, in Bhiwandi, and in the town of 14,641; 14,076;
Banga in the Punjab. In Bangalore there seems to have been considerable mortality 14,492; 14,493
among these animals; squirrels were seen to fall down dead when trying to jump 10,136.
from one branch of a tree to another; in particular, we are told of a great
number of dead squirrels being found in and around a plague-infected house. In
Hubli squirrels appear to have been exterminated. In Poona the mortality among
them was so heavy that Colonel Fawcett, R.A.M.C., said: "In December 1897, when

plague was very bad, I noticed squirrels crawling along the road, and not able to go up the trees. Then I heard some people say they saw three squirrels drop off the trees dead. After that I could at any time find the corpse of a squirrel about here if I looked for one." In view of the above facts, it can hardly be doubted that squirrels, which are, in India, both numerous, and tame enough to go into houses, may possibly constitute one among the less important agencies by which plague may be disseminated.

Monkeys.
93; I. 378; 9119; 8590.
2444, 3113-5.
14,079; 14,243, 14,503; 14,641, 15,381; 19,643; 23,604.
19,643.
8779.

280. Epidemics of plague have been observed among monkeys, both among the brown monkeys (macacus radiatus) and the more susceptible grey monkeys (semnopithecus entellus). In particular, an epidemic of plague occurred among the monkeys at Hardwar and the neighbourhood, the plague bacillus being found by Mr. Hankin in nine out of 26 monkeys examined. Mortality among monkeys was reported also from Hubli and the adjoining town of Gadag, and, further, from Ankleshwar, Baroda, Dharwar, the Thana district, and the village of Dhunadra in the Kaira district. With reference to Dharwar, we were informed that the deaths occurred among "the brown monkeys which live about houses, and will go into the interior and get food." Speaking of a village in the Thana district, Mr. Monteath said: "When the village was evacuated, large numbers of monkeys used to enter the houses by the gaps made in the roof seeking what they could steal. I noticed, on riding into the village on one occasion, a monkey drop dead from a tree above the chawdi. On inquiry I learned that 10 to 12 had died similarly, some in the houses. Coming again to the village a few days later, I was told that five or six more had died." From the above facts, it will be apparent that plague-infected monkeys may come into sufficiently close communication with human beings and their habitations to constitute a possible source of infection. This being so, it is clear that Mr. Winter was well advised to take steps, during the plague epidemic among monkeys at Kankhal, to rid the town of these animals by having them trapped, with a view to their being carried away into the jungle after they had been kept in confinement for a period sufficient to ensure that they were free of plague.

Cats.
26,316.
Report of Austrian Plague Commission, II. C., pp. 707-8.
11,311, 11,839; 18,990, 24,310; 1187-8, 20,423; 14,641; 14,079.
14,484.

281. Among the animals which may play a part in the dissemination of plague must be reckoned also cats. The disease can be communicated to these animals not only by hypodermic inoculation, but also by feeding them on plague-infected food. In connexion with the possibility of the disease being contracted by cats in this manner, reference may be made to the fact that the Austrian Plague Commission succeeded in communicating plague to a series of three cats by feeding them on the bodies of animals dead of the disease. It is to be noted, however, that only one of these cats contracted the disease in an acute and rapidly fatal form; in the case of the two others the disease manifested itself in a very chronic form, characterised by the development of buboes in the neck and great wasting. The epidemiological observations made in India seem to harmonise with these bacteriological observations. Disease among cats in association with plague was noticed particularly in Karachi and Ahmednagar, and also in Bombay City, Baroda, and Umreth; the animals are described as having suffered from buboes in the neck and from wasting. In one case, it was suggested that the infection of plague was directly conveyed to a person by an infected cat; here, however, there were other possible sources of infection.

Dogs, jackals, and birds.
Para. 134 of this Report.
7187: I. 474.
II., 338.
Report of the Austrian Plague Commission, Part II., C. pp. 704-5.

282. Since, as we have seen, dogs, jackals, and birds are very insusceptible to plague, the influence of these animals in disseminating the infection can come into consideration only in connexion with the possibility that the bodies of animals dead of plague or portions of these may be carried about from place to place by carnivorous animals, and in connexion with the possibility that plague bacilli ingested in food may pass through the intestinal canal of these animals without loss of virulence. With regard to the first contingency, it will suffice to remark that plague may, in exceptional cases, be spread in this way. To exemplify this we may refer, on the one hand, to a case observed in Calcutta, where a dog carried into a a room a rat dead of plague and laid it on a bed, and, on the other hand, to the case of the infected villages in Kumaun, where, as we learn from Surgeon-General Planck's Report on mahamari, the dead were, owing to the dread of plague, often left unburied, with the result that jackals came and dragged the bodies about through the village site. In connexion with the possibility of plague bacteria passing unchanged through the intestinal canal of carnivorous animals, it will suffice to note that the Austrian Plague Commission, though they failed to infect dogs by feeding them on plague-infected material, were able to detect highly virulent plague bacilli in their excreta.

Insects.

Section IV.(4) of this Chapter.

283. In addition to the animals we have noticed above, insects may, it has been suggested, carry about the infection of plague. We have already considered the case of suctorial insects, and there remains to notice only the possibility that ants and flies may carry about infective material. The possibility of plague being conveyed by ants was pointed out by Mr. Hankin, who in one or two instances discovered the plague bacillus in ants which had been at work on the body of plague-infected rats. The conveyance of plague by infected flies is adverted to by Dr. Nuttall. This observer considers that since flies succumb when fed on plague-infected material, the disease may possibly be spread by infected flies dropping into food. In view, however, of the fact that plague does not, at any rate in the case of man, appear to be contracted by means of the alimentary canal, we do not think that any great importance in connexion with the spread of the disease can be attached to the contamination of food by infected flies.

8530-1.

Johns Hopkins Hospital Reports, Vol. VIII., 1899, p. 16.

IX.(6.) *Question whether any Agencies other than those already discussed Play a Part in the Spread of Plague.*

The question as to whether there are any other agencies by which plague may be carried about.

284. The question as to whether there are any agencies other than those already considered by which plague may be carried about now comes up for consideration.

Wind.

Some witnesses, and Lieut.-Colonel Waters, I.M.S., in particular, entertained the opinion that the wind was a very important agent in spreading the infection of plague. His views on the subject appear to us to lack all serious basis. They would seem to be based, first, on the fact that the Umarkhadi Jail, which was under Lieut.-Colonel Waters' superintendence, remained for a long time free from plague, though the disease was raging in the surrounding quarter of Bombay; and, secondly, on the fact that some of the first rooms in which plague occurred in Bombay were situated in corner houses or in upper storeys. The interpretation which Lieut.-Colonel Waters placed upon the circumstance that cases did not for a long time break out in the Umarkhadi Jail was that the conveyance of the plague into the jail by the wind was prevented by the high wall which surrounded the jail. Similarly, the interpretation which Lieut.-Colonel Waters placed upon the occurrence of the first cases of plague in certain corner houses and upper storeys was that these places are particularly exposed to "the prevailing breeze" blowing from the Mandvi quarter. We may remark that it was only in connexion with a few of the first cases in Bombay that corner houses and upper storeys were found to be specially attacked. Of the other witnesses who came before us Major Corkery, I.M.S., who also seems to have thought that plague is spread by the wind, had an impression that in Sukkur and in the Dharwar Jail infection was carried by the wind along the ground.

17,033-7.

17,015-6; 17,032.

2252.
2275.

Suggestion that spread of plague by agencies already considered does not account for reappearance of plague on confines of evacuated areas.

285. It is in connexion with the frequent reappearance of plague on the confines of an evacuated area that the suggestion has been most forcibly brought forward that agencies other than those of men and animals may be involved in the dissemination of plague.

This idea has forced itself, in particular, upon Mr. Cappel in the case of Hubli, and upon Mr. Winter in the case of Jawalapur. Mr. Winter was apparently of opinion that plague spread outwards, after the evacuation of an infected area, in a centrifugal manner from the original focus of infection in the evacuated area by means of some agency other than that of men or rats. With a view to placing before us the exact facts on which he based his opinion, Mr. Winter caused a map to be prepared, upon which were indicated the houses in the neighbourhood of the evacuated area where the successive cases occurred subsequent to evacuation. The map which was furnished to us is printed as Appendix No. XXXVI. to our Proceedings. A study of it seems to show that plague, though in the case in question it spread outwards from the evacuated area, spread out in a somewhat irregular manner, such as might have been expected if men or rats were the agents in distributing the infection. This conclusion is, we may note, in conformity with the opinion of Captain Elphick, I.M.S., who studied the events on the spot. In connexion with the occurrence of plague cases on the confines of the areas successively evacuated in Hubli, it was suggested that the infection might have spread outwards by growing along the ground. This particular suggestion must, of course, be rejected as inconsistent with bacteriological facts.

1645-7;
9276-8.

9580-2.

1707.

To return to the more general issue, it will be manifest that before the dissemination of infection by means of the wind, or by means other than men or rats, can legitimately be brought in to furnish an explanation of the reappearance of plague on the confines of an evacuated area, the agency of men or rats must be excluded. It is conceivable, for instance, that, before evacuation, clothes from the evacuated area may have been deposited in the neighbouring houses, or that people from the evacuated area may have transferred themselves to those houses, and again, it is possible that the evacuated area may not have been effectively cordoned, and that visits may have been paid by the people on the confines of the evacuated area to the houses within that area after the evacuation had taken place.

Water.

286. Before passing on to summarise what has been said above with regard to the various agencies which are at work in disseminating plague in an infected place, we have still to consider the possibility of the infection being disseminated by means of drinking water. This suggestion was originally put forward in connexion with Hong Kong, where it was claimed that the plague bacillus had been discovered in well water. The only fact which has come to our notice which would harmonise with this 18,881-2. suggestion is the fact that Dr. Marsh succeeded in cultivating the plague bacillus from water, which had been previously artificially infected, after 44 days in the case of sterilised water, and after 6 days in the case of ordinary tap water. In this 10,120. connexion we may observe that in the case of Malpur, an infected village in the Punjab, the water of a particular well in the evacuation camp was regarded with suspicion by the natives because plague-infected rats had been seen to jump in and drown themselves in it. It must, however, be carefully noted that this is the only instance brought to our knowledge where water fell under suspicion, and even here it appears to have been suspected only on *à priori* grounds. It would seem, therefore, to be established that water plays no part in the dissemination of plague.

IX.(7.) *Summary regarding the Agencies by which Plague is spread in an Infected Place.*

Difference of opinion regarding the relative importance of men and rats in disseminating the infection of plague.

287. All that has been said above has gone to show that plague is practically always spread, either by human agency (and for present purposes we include under this term the agency of infected clothes or merchandise carried about by man), or by the agency of rats. It remains, in conclusion, to endeavour to arrive at an estimate of the relative importance of these two agencies in the dissemination of the infection of plague within the limits of an infected town or village. On this question a variety of different opinions have been expressed.

Opinions that, apart from rat epidemics, human plague epidemics cannot occur.

288. One witness went so far as to say, "I believe if there was a single house which contained infection, as soon as there is a colony of new rats they get themselves infected and spread the plague. After the plague has been over the place, and all the rats are dead, for the time being the plague subsides. Then there comes a fresh 17,837. colony of rats."—The opinion of Captain Mason, R.A.M.C., is essentially to the same Appendix XLVII. II. p. 477. effect. "In no village," says this officer, "in which there has been no epidemic among rats has plague spread among the people. In other words, I firmly believe that imported cases of plague do not cause epidemics, provided the rats be not infected."— Annales de l'Institut Pasteur, Oct. 1 1898. Dr. Simond, as we have already seen, takes the same view. He takes it as certain that epidemics of plague do not occur in villages unless preliminary epidemics of plague occur among rats, and, like the first witness quoted above, he attributes the seasonal increase of plague, which is so noticeable a feature in many plague-infected places, to a seasonal immigration of rats, which is followed in its turn by an increase of plague among men.

Captain Mason's experience of plague, and the same holds true to a large extent also of Dr. Simond's experience, was based on observations made in the Cutch State. It is, Para. 272 of this Report. II. 480. therefore, important here to call attention to the fact that Major Hyde-Cates' evidence already cited above, to the effect that there was very little mortality among rats in this part of India, would appear to throw serious doubt on the correctness of Captain Mason's and Dr. Simond's views. Moreover, we have evidence derived from places outside Cutch which shows that the extreme views of these observers cannot be upheld, and we have cited cases of outbreaks, both in towns and villages, which have been either quite, or at any rate in large part, independent of the occurrence of epidemics among rats.

Opinions that influence of rats in spreading plague greater than that of man.

289. Apart from opinions which entirely subordinate the agency of man in the spreading of plague to the agency of rats, there is a large divergence of opinion as to the relative importance of the roles which are played by rats and men respectively in the distribution of the infection. Mr. Giles considered the influence of rats in 11,278. spreading plague much more important than any other agency.—Lieut.-Colonel 11,414. McCloghry, I.M.S., shared this opinion.—Mr. Katrak regarded man as a "much less 17,925. important factor than rats" in the spread of the disease.—Lieut.-Colonel Weir, I.M.S., 1005, 1168. the Health Officer of Bombay was, as we gather, also strongly of the same opinion.— 22,618. Lieut. Anderson, speaking of the spread of plague in the villages in the Satara District,

stated that in his opinion rats were the chief agents in carrying plague from house to house within a village. His experience of the second epidemic in Karachi was that 22,646. the disease was "conveyed entirely by rats."—Lieut. Steen said, "Rats, I think, 22,693. there can be little doubt, disseminate the plague in a village, once the infection has been imported by human agency. Communication may exist, and often does, amongst the careless villagers, but when cases of plague are found occurring in totally different and well separated parts of the village, and amongst the highest and lowest castes at the same time, there can, I think, be little doubt that rats have spread the plague over the villages, especially as large numbers of these vermin are, as a rule, found dead in the village, either before or at the same time as the occurrence of cases amongst the inhabitants."

Opinions that influence of rats in spreading plague is not important.

290. On the other hand, a certain number of witnesses, although numerically they constitute a comparatively small minority, have either not observed that any great influence on the spread of plague exercised by the existence of plague among rats, or do not believe that its influence is important. Mr. Stewart, who worked in Bombay and Nasik, had never been able to trace the spread of infection by the agency of rats. He said that in Nasik he had found practically no rats in plague-infected houses—in 16,960, 16,962, fact, he said, "We have had no signs of conveyance by means of rats in Nasik at 16,998. all."—Major Reade, R.A.M.C., who was in charge of the plague operations in Poona, said, in his first examination before us, that there had never been any great mortality among rats in Poona, but when he appeared again before us, a month afterwards, he 21,723-4. observed: "We have evidence now with regard to rat infection, and it shows that in 25,831. a small radius there is undoubted infection by rats, though a localised one. Rat infection has not played a large part in the recent outbreak in Poona. As a source of infection to men it is one I have had little knowledge of up to the present date"—(Major Reade was, we understood, speaking also in the light of his experience of plague in Hong Kong)—"but from our experience at Poona I am inclined to believe the influence of this infection has been much exaggerated."—Dr. Clemow states that 7188. in the course of a systematic inquiry in Calcutta he could trace a history of dead or sick rats in seven only of 32 houses in which plague had occurred.—Lieut.-Col. Nariman, 15,886. I.M.S., who was speaking of Surat, had never seen a case of plague which could be traced to a rat.—Mr. Judge, who had experience in Surat and Daman, was convinced 16,045. that plague spread along the lines of human communication. In the case of Surat, Mr. Judge furnished us with a map based on a systematic investigation into the causes App. No. LIV. of a whole series of plague cases. In practically every instance these cases were found to have originated from human intercourse.—At Ahmednagar the experience was that 24,090; 24,303. plague was communicated almost entirely by human agency.—In the case of plague in Baroda City, Dewan Bahadur V. M. Samarth said that "people at a long distance 14,608. from one another were found to be infected, and the reason often traced was that they had paid visits to one another, or that an actual plague case was removed clandestinely and put into another house."

Observations bearing on part actually played by human agency and by rats in spreading plague in particular places.

291. We have cited above the most important opinions expressed to us with regard to the relative influence of rats and men considered as agents in the dissemination of plague. Some further light may, we think, be thrown on the question by considering certain observations regarding the manner in which plague has spread from house to house in an infected place, and regarding the question whether social intercourse between the residents, or whether contiguity of position is the factor which exerts the greater influence on the spread of plague from house to house. Mr. Lord, in answer to a question as to how plague appeared to be carried from one 19,005. house to another within a town, replied: "I suppose by human agency, but I must say, that as far as I could see, in big blocks of houses, it did not pass from one house to other houses adjoining it in other streets (*e.g.*, touching back to back, with doors in different streets) but travelled up the street, *i.e.*, it probably was brought through the doors and not the walls."—On the other hand, with regard to this particular point, 10,454. Captain Wilkinson, I.M.S., gives two specific instances, in the villages of Lidhar Kalan 10,456. and Bika in the Punjab, where the agency of rats must have been involved, inasmuch as plague spread between houses whose doors were approached from different sides and whose inmates could have had no communication with each other. Maps explaining the special features of these two cases have been furnished to us and are published in our Proceedings. App. XXXVII. A similar case, also illustrated by a map, was reported from the town of Garshankar in the Punjab. App. XXXVIII. 10,845-54—The evidence, however, relating to Kariha, also a village in the Punjab, points in a contrary direction. App. XXXIX. We are told that this village is inhabited by five sections of people, three of which were agreed in holding 10,123-6.

no communication with the other two. Here, though rats were infected, the outbreak was in large part confined to the two sections who held communication with each other.—Mr. Shepherd, however, the Assistant Collector of the Thana district, observed in his district that plague did not spread among particular classes of the community as it did in Kariha. He drew his experience from a district where plague was epidemic both among rats and among men, and, in stating his opinion that the dissemination of plague by contact with infected persons was extremely rare, said : " If dissemination was chiefly by contact, considering the way the people live in the villages, we should get a certain class of people infected first. If it began among a certain caste, several members of that caste would be infected before others; but, as a matter of fact, we do not find that to be the case."—Finally, we may remark here that human agency, and not the agency of rats, must almost wholly have been responsible for the spread and continuance of plague in evacuation camps, which we have noticed elsewhere in this Report.

18,789.

Sects. III.(2) and (3) of Chapter VI. of this Report.

Conclusions regarding relative importance of men and rats as agents in disseminating plague in an infected place.

292. It will be obvious that, in view of the conflict of opinion disclosed above, it is difficult to obtain a basis for safe generalisation as to the relative importance of rats and men as agents in the dissemination of plague. In some places men, and in other places rats, appear to have been the agents which were most directly involved in the dissemination of the infection. The conclusions which we have derived from a study of the evidence may, perhaps, usefully be presented in the following form :—

(1.) In some places, where severe epidemics have occurred among men, rats have not been infected at all,* and in many places, where there have been plague epidemics among men, the disease has not appeared among rats in epidemic form ;

(2.) Occasionally, where there has been considerable mortality among rats, there has been an absence of plague among men ;

(3.) Even when there has been the largest amount of plague among rats, the risk to the persons who came in contact with these infected rats appears not to have approached that undergone by persons inhabiting houses in which there have been plague patients, or persons coming into contact with pneumonic plague ; there are, however, cases, such, for instance, as the case of Mahlgahla, and the case of Chak Kalal, where a very considerable number of plague cases in a village has been directly attributable to the dissemination of infection consequent on an epidemic of plague among rats ;

(4.) Since the number of plague bacilli escaping from the infected human organism must be presumed to be greater than the number which escape from a plague-infected rat, *à priori* it would seem clear that a single infected man must constitute a greater danger than a single infected rat; but, on the other hand, seeing that the excreta of rats may be deposited anywhere throughout a house, and that the number of rats which are affected may many times exceed the number of men who are affected, a severe epidemic among rats must, we think, tend considerably to the spread of infection ;

(5.) The chief importance of rats in the epidemiology of plague seems to us to arise in connexion with the first outbreak of the disease in an infected place, for we have seen that in many instances rats become infected before men, and they scatter plague broadcast over an uninfected place ;

(6.) When plague is once established in a place, we have no doubt that human agency is a more important factor in spreading the disease than the agency of rats.

Slow rate of spread and persistence of infection in localities once infected marked feature of spread of plague within infected places. 1645.

293. Before leaving this part of our subject, we think it advisable to emphasise the fact that the most striking characteristic in connexion with the spread of plague through a place is its slow and steady advance from one group of houses to another, and its long persistence in a quarter that has once become infected. As Mr. Cappel said, in speaking of the way plague spread in the commencement of the epidemic at Hubli :—" The cases were all grouped together, and for weeks, and I may say for months, we were engaged in combating the plague in the particular area which was contiguous to the original place of infection in the town itself, and that infection moved steadily on from that centre. . . . . It spreads very slowly from locality to locality within the town." Mr. Cappel considered that this slow movement of plague showed that the disease was not spread mainly by human agency, for he said :—" If

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Zeitschrift für Hygiene, 1901.

* It is noteworthy in this connexion that the minute bibliographical researches of Dr. Rudolf Abel, extending over the whole field of classical, mediæval, and modern, literature, bring out clearly that there are no records of epidemics among rats occurring concurrently with plague among men. The only striking reference to plague mortality among rats which Dr. Abel has succeeded in discovering is the following from Avicen (A.D. 1000), " Et de eis quæ significant illud [the approach of plague] est ut videas mures et animalia quæ habitant sub terra fugere ad superficiem terræ et pati *sedar*, *i.e*, commoveri hinc inde sicut animalia ebria."

the infection were mainly spread by human agency within given town limits, we should expect to find the infection appearing in all parts of the town at the same time, but that was not the case either at Hubli or Dharwar." This assumption, it will be noted, is precisely the same assumption as that which came under review as an objection that might be urged against the spread of plague by human communication along the lines of railway; but just as there we saw that the slowness of the spread of plague throughout India, and its gradual progress by short steps, are probably due to the fact that it generally was not till after a considerable stream of infection had flowed through a town that the disease was able to establish itself there, so here, in the case of an infected town itself, we think that, leaving out of consideration the exceptional cases, a large inflow of infection must take place into each quarter or house in order to establish the plague there, and we consider that this fact explains the slow and gradual spread of plague within the limits of infected places. 1645.

Section VII.(5.) this Chapter.

X.—CIRCUMSTANCES WHICH INFLUENCE INDIVIDUAL LIABILITY TO PLAGUE.

X.(1.) *Influence of Age on Liability to Plague.*

Influence of age on liability to plague.

294. Having discussed the general question of the manner in which plague spreads, we may pass to consider the more important of the circumstances which may influence the liability of the individual to contract plague.

Observations regarding statistical matter bearing on relation of age and plague.

In this connexion we may consider first the question of the influence of age on liability to plague. We have collected below in tabular form all the more important information which is at our disposal with regard to the incidence of plague at different ages of life. Before proceeding to set forth these figures, attention may be drawn to the following points. (*a.*) The figures giving the incidence of plague refer, for the most part, to attacks; when, however, the number of attacks has not been furnished, the figures for deaths have been employed for determining the incidence of plague at different ages. The inclusion of these figures, in a table designed to exhibit the incidence of plague at different ages, would appear to be justified, for, though the prognosis in the cases of children is slightly better than in the cases of adults, the case mortality of the disease is, as will be clear from a reference to Table III. in our Statistical Appendix, not influenced to any important extent by the age of the patient. (*b.*) With a view to furnishing a standard of comparison by which to determine whether there is or is not any increased or diminished susceptibility to plague at different ages, we have, in the case of each age group, given figures representing the number of persons of that age group to be found in the community. With regard to these figures, it is to be observed that, in the case of Bombay and other places where it was practicable, we have given the percentage of persons of each age group as deduced from the census figures of 1891 for the particular places in question. In the case of places in the Punjab, we have taken the figures for the Province as given in the census of 1891. In other places we have taken the figures representing the percentage of persons in the age groups in question, as deduced from the census returns of 1891, for the whole of India.

Appendix I. to this Report.

The table we have prepared is shown on the next page.

Conclusions from above table.

It will become manifest, on comparing the columns denoted by (*a.*) and (*b.*) respectively, in the table under each age group, that the incidence of plague during the first five years of life is much less relatively to the number of persons of this age in the population than it is at any other period of life. There would seem to be—though the figures are less clear on this point—a similar, though less marked diminution in the incidence of plague at the other extreme of life. As a necessary consequence of this diminished rate of incidence at the two extremes of life, there is a correspondingly increased rate of attack in the period of adult life.

Remarks regarding variations in ratio of children attacked in different places.

A point of minor importance which may be noticed in connexion with the table, is the variation in the ratio in which children were attacked in different places. The ratio which the number of the children who succumbed to plague bears to the number of the children in the population is, in the case of Bombay City, represented by the ratio of 1 to 5·7; the ratio borne by the number of the children attacked to the total number of the children in the population is, in the case of the Jullundur villages of the Punjab, represented by the ratio of 1 to 2·3. The reasons for this variation are not altogether clear. It may, however, be surmised that the difference in the ratios is conditioned, to some extent, by the fact that there was greater opportunity for concealment in the case of Bombay City than in the villages of the Punjab, where the staff employed on plague measures was adequate to secure the discovery of most cases even among children, in whose case concealment is most easily effected. Moreover, the population of children on which the incidences are calculated is that of 1891, and,

TABLE SETTING FORTH INCIDENCE OF PLAGUE AT DIFFERENT AGES OF LIFE.

Place of Observation.	Whether the Figures refer to Cases or Deaths.	Total Number of Persons who were attacked by or who died of Plague.	Percentage of (a) Plague Cases or Deaths, and of (b) the Population under Observation which falls to each Age Group.										Authority for Figures
	Age Groups -		0–5.		5–10.		10–50.		50–60.		Over 60.		
			(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	
Bombay City - - - -	Deaths	1,936	1·4	8·0	7·3	8·2	84·3	74·7	4·4	5·6	2·6	3·5	Snow's Report, 153.
,, Arthur Road Hospital -	Cases	4,000	1·4	,,	4·7	,,	87·3	,,	4·2	,,	2·4	,,	Evidence III., 459.
,, Grant Road Hospital -	,,	1,230	2·7	,,	8·1	,,	84·6	,,	3·2	,,	1·4	,,	Gatacre's Report, p. 111; Campbell's Report, p. 140.
,, Parel Hospital - -	,,	1,296	2·1	,,	7·4	,,	84	,,	4·5	,,	1·5	,,	Campbell's Report, p. 115.
,, Mahratta Hospital -	,,	650	1·7	,,	10·3	,,	83·6	,,	Over 50 = 29 per cent.				Gatacre's Report, p. 48.
,, Jain Hospital -	,,	510	0·8	,,	3·0	,,	92·7	,,	2·2	5·6	1·3	3·5	Gatacre's Report, p. 151.
Ankleshwar - - -	,,	331	2·1	,,	9·0	8·6	79·1	74·9	6·6	4·5	3·2	3·3	Evidence, 14,394.
	Age Groups -		0–5.		5–60.						Over 60.		
			(a)	(b)	(a)			(b)			(a)	(b)	
Baroda City - - -	Deaths	1,620	1·7	9·9	96·3			83·9			2·0	6·2	Evidence, 14,982; 15,364.
Baroda Villages - -	,,	1,094	4·3	12·0	89·6			85			2·1	3·0	Mr. Mehta's evidence; App. LII.
Calcutta - - -	Cases	183	3·3	7·3	93·6			84·2			7·1	8·5	Evidence, 6518; I. 474.
	Age Groups -		0–5.		5–10.		10–50.		50–60.		Over 60.		
			(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	
Jullundur Villages - -	Cases	2,706	7·3	17*	11·5	14*	71·0	56·8*	7·0	6·5*	3·2	5·7*	Evidence, 10,330.
Banga - - - -	,,	103	8·7	,,	12·6	,,	63·2	,,	14·6	,,	·9	,,	,, 10,178.
Daman - - -	Deaths	625	6·2	14·7†	10·6	14·1†	70·0	59·8†	8·3	6·0†	4·9	5·4†	,, 16,511.
Karachi Hospital - -	Cases	515	4·1	,,	11·1	,,	79·2	,,	3·9	,,	1·7	,,	,, 12,343.
Kotri - - -	,,	100	4	,,	14	,,	75	,,	7·2	,,	0	,,	,, 12,649.
	Age Groups -		0–10.				10–50.		50–60.		Over 60.		
			(a)	(b)			(a)	(b)	(a)	(b)	(a)	(b)	
Poona, Sassoon Hospital - -	Cases	192	4·7	28·8†			88·5	59·8†	4·7	6·0†	2·1	5·4†	Evidence, II., 192.
Umreth - - -	,,	110	17·3	,,			75·5	,,	7·2	,,	0	,,	,, II., 233.
Palanpur - - - -	,,	815	11·8	,,			78	,,	7·5	,,	2·7	,,	,, II., 200.
	Age Groups -		0–5.		5–60.						Over 60.		
			(a)	(b)	(a)			(b)			(a)	(b)	
Porbandar - - -	Deaths	257	2·2	14·7†	90·8			79·9†			7·0	5·4†	Evidence, II., 484.
Bangalore, South Camp Hospital -	,,	256	5·8	,,	88·8			,,			5·4	,,	,, 2923.

* These figures have been calculated from the 1891 Census Returns for the whole of the Punjab.

† These figures have been calculated from the 1891 Census Returns for the whole of India.

as will be seen in connexion with statistics regarding the incidence of plague as influenced by sex, there is reason to believe that in Bombay and other large towns the population of males is increasing in greater proportion than the population of females. Hence it may be assumed that the percentage of children in the population of Bombay is at present less than it was in 1891, and that the number of children assumed to be present, and adopted in our table as the basis for the calculation of the incidence of plague in the first ten years of life, is unduly high. On the other hand, there is nothing to suggest that in rural areas—such as the portion of the Punjab which has been visited by plague—the number of males is increasing relatively to the number of females. For the Punjab, therefore, the census figures of 1891 are likely to represent more correctly than for Bombay City the actual percentage of children in the population.

Para. 295 of this Report.

X.(2.) *Influence of Sex on Liability to Plague.*

Influence of sex on liability to plague.

295. The next point that comes up for consideration is the question of the relative incidence of plague in the different sexes.

Points to be borne in mind in considering statistical matter regarding relation between plague and sex.

Before setting forth the statistical matter which we have collected on this question, it will be useful to call attention to certain facts with regard to the proportion of women in the population of India. The percentage of women, worked out on the census figures of 1891. amounted to 47·9 per cent. of the total population of India. In large cities the percentage of women to the total population was considerably less; in Bombay it amounted to 36·9 per cent., in Calcutta to 36·5 per cent., and generally, in the whole population of all the Indian towns which contain more than 100,000 inhabitants, to 35·3 per cent. Since no later figures than those of the census of 1891 are available, it must be borne in mind that the census referred to bore witness to an increase in the previous decennial period of males in the population of large cities at the rate of 12·89 per cent., while the increase of females in the population of these cities was represented by the figure of 7·6 per cent. only. It is, therefore, probable that the census figures of 1891, which we have used for the purposes of comparison, exaggerate the proportion of females in the population of large towns. The plague incidence in the female population ought, therefore, to be calculated on a basis of a smaller number of women.

Statistics for Bombay City bearing on the respective liability to plague of the two sexes.

296. These points having been premised, we proceed to set forth for Bombay City the figures compiled by Lieut.-Colonel Weir, I.M.S., regarding the incidence of plague among men and women respectively. We may note that the death returns, as being more accurate than the returns relating to the number of attacks, have been made use of for determining the relative incidence of plague in the two sexes. The figures are as follows:—

TABLE showing the NUMBER of DEATHS in BOMBAY from BUBONIC PLAGUE in different CASTES, and the DEATH RATE per Mille of the Population of BOMBAY CITY in the Year 1896.

(Snow's Report, pp. 152–3.)

Classes.	Males.			Females.		
	Population.	Number of Deaths.	Rate per 1,000.	Population.	Number of Deaths.	Rate per 1,000.
Jains - - - -	19,317	168	8·69	5,908	40	6·77
Brahmins - - -	26,554	70	2·63	11,418	20	1·75
Lingaèts - - -	462	6	12·98	322	—	—
Bhatias - - -	4,344	19	4·37	3,547	4	1·12
Hindus of other caste - -	288,569	811	2·79	162,896	379	2·32
Hindus of low caste - -	25,888	78	3·01	19,281	34	1·76
Mussulmans - - -	94,975	113	1·18	60,126	41	·68
Parsees - - - -	24,705	41	1·65	22,753	26	1·14
Jews - - -	2,590	6	2·31	2,431	4	1·64
Native Christians - -	20,040	55	2·74	9,672	15	1·55
Eurasians - - -	2,294	2	·87	2,036	2	·98
Europeans - - -	8,118	1	·12	3,172	—	—
Negro Africans - -	90	—	—	56	1	17·85
Chinese - - -	137	—	—	53	—	—
Other and unknown castes -	— (*sic*)	—	—	—	—	— (*sic*)
Total - - -	518,093	1,370	2·63	303,671	566	1·83

Lesser incidence of plague among women due to over-estimate of female population and to concealment of cases among women.

These statistics show a much smaller incidence of plague among women than among men, the rates of incidence calculated upon the figures for 1891 standing to each other in the proportion of 71 to 100. The causes of this smaller recorded incidence of plague are to be found not in a lesser case mortality among women, (as will be clear from a reference to Table II. in Appendix I. to this Report), but in the over-estimation of the female population resulting from the relative increase of the male population in large cities referred to above, and also in the fact that cases of plague occurring in women were more often concealed from the authorities than those among men.

Concealment of cases among women established on comparison of admissions to hospital with death returns of City. Gatacre's Report, pp. 48, 111, 124; Campbell's Report, pp. 115, 139, and 150; Evidence III., 459.

Testified to also by different rates of attack in different native communities.

The concealment of cases of plague among women is testified to by two facts. The first of these facts is that the admission returns to the Bombay Plague Hospitals show that the number of women admitted stands to the total number of admissions in the proportion of 1 to 4 in a total of 6,970 cases, while the recorded death rate for the total female population stands to the recorded death rate for the total male population in the ratio of 1 to 2½ nearly, thus witnessing the reluctance of the people to disclose plague among women, unless where it may be absolutely necessary for the purposes of carrying out the obsequies. The frequent concealment of plague cases among women is testified to further by the fact that the per mille death rate in the male and female population is entirely different in the various communities and castes which are included in the population of Bombay. The fact that the figures set forth in Lieut.-Colonel Weir's table, given above, testify to the concealment of plague cases among women appears clearly when the figures are exhibited in the following form:—

Community.	Proportion in which Plague Deaths recorded among Women stand to the Plague Deaths recorded among the Total Number of Persons in the Community.	Proportion in which the Number of Women in the Community stands to the Total Number of Persons in the Community.	Ratio in which Deaths among Women stand to the Number of Deaths which might have been expected on the Assumption that the Proportion of Deaths among Women would correspond to the Proportion of Women in the Community.
Hindus	*477 in 1,629* or 1 in 3·4	*203,372 in 568,506* or 1 in 2·8	82 per cent.
Muhammadans	*41 in 154* or 1 in 3·75	*60,126 in 155,101* or 1 in 2·6	69 per cent.

It will be seen from these figures that the proportion of plague deaths among women to the total plague deaths in the particular communities which we are considering is considerably less in the case of the Musalmans, who practice the rigid seclusion of their women, than in the case of the Hindus, who do not to the same extent insist upon such seclusion. If further proof be required that there was a considerable amount of concealment of plague cases occurring among women in the Musalman community, we may obtain such evidence from the consideration of the statistics of the Bombay Plague Hospitals. To take the figures of the Arthur Road Hospital, which is the largest of the Bombay Hospitals, we find that, whereas the number of Musalman men who were admitted into hospital was 229, the number of women of that community admitted was only 34, while, on the basis of the census figures of 1891 which set forth the relative numbers of men and women in the Musalman community in Bombay, 88 women might, on the assumption that men and women are equally liable to plague, have been expected in the hospital. It would thus appear that the recorded lesser incidence of plague among women in Bombay City must in large part, in particular in the Musalman community, be due to the concealment of cases among women.

App. LXI. in Vol. II. of our Proceedings.

Further consideration of influence of concealment.

On consideration, however, of the table given above, and further, of the hospital statistics, it would appear to be almost certain that concealment does not in every case account for the smaller rate of attack which is set forth in the official statistics. It will be seen that in the case of Native Christians—a community which does not practise seclusion among women, and which is least likely to conceal the occurrence of plague among them—the number of plague deaths among women (which amount to little over 20 per cent. of the total number of plague deaths in the community) is very much smaller than might have been expected from the relative numbers of Native Christian men and women (women constituting about 33 per cent. of the census population of the community in Bombay). As a matter of fact, the deficit of plague deaths among women is a little greater among the Native Christians than among Muhammadans. We cannot suggest any explanation of this circumstance.

Statistics for places other than Bombay City bearing on relation between sex and plague.

297. Passing now from Bombay to the consideration of figures relating to the incidence of plague among women in other places, we may set forth at this point in tabular form the statistics which we have collected. The table is as follows:—

TABLE SHOWING INCIDENCE OF PLAGUE IN MEN AND WOMEN RESPECTIVELY.

Place of Observation.	Authority for Figures.	Whether Figures refer to Cases or Deaths.	Total.	Male.	Female.	Percentage of Females in Total.
Calcutta City	I., 474	Cases	190	152	38	20
Surat	15,645	„	114	78	36	31·6
Karachi City	II., 424	„	3,238	2,174	1,064	32·8
Bangalore Hospitals	2,913–2,923	„	468	280	188	40·2
Baroda City	15,219	„	1,620	910	710	44
Sassoon Hospital, Poona General Hospital, Poona	II., 192 Report for period from 1/6/97—31/3/98	„	3,584	1,860	1,124	48·1
Kotri	12,649	„	100	65	35	35
Umreth	14,047	„	110	64	46	42
Satara	22,279	Deaths	644	344	300	46·6
Baroda Villages	15,219	Cases	2,065	1,085	980	47·3
Palanpur	13,159	„	672	290	382	57
Porbandar	II., 484	„	463	200	263	57
Mandvi Hospital	I., 352	Deaths	2,953	1,226	1,727	58·5

The most striking point in this table is the great difference in the figures relating to different places. To begin with the case of Calcutta: we find that here, out of the very small number of cases that came to light, those among women amounted to only 20 per cent. of the whole. This can hardly be due to anything else but 6576. concealment, even if we make an allowance for the fact that the percentage of 36·5 of females in the population which was shown in the Census of 1891 must be somewhat in excess of the present percentage of women in the City. In the case of Surat and Karachi, the percentage of cases among women to the total cases is 31 and 32 per cent. respectively. These figures approximate fairly closely to the figure 35·3, which, as we have seen above, represented in 1891 the percentage of women in the populations of Indian towns containing over 100,000 inhabitants. Unless, therefore, it is conceivable that in Surat and Karachi only a very few more cases were concealed among women than among men, the statistics for these towns would seem to indicate that the incidence of plague is at least as high among women as among men. We find confirmation—and more than confirmation—of this indication when we consider the other large towns for which we have figures. In Bangalore, Baroda, and Poona—each of which contains well over 100,000 inhabitants—the percentages of plague cases which occurred among women, computed on the total of plague cases, are 40, 44, and 48 per cent. respectively—percentages which are in excess of the average percentage, 35·3, of women in the population of Indian towns of over 100,000 inhabitants. In view of the fact that we are, in the case of Poona and Bangalore, dealing with hospital figures, which always show an unduly low percentage of female cases, and further seeing that we have had direct evidence of the concealment of cases among women in 25,022. Bangalore, it will be obvious that the real percentage of women attacked must have been in excess of the already large reported percentages. The cities in question, therefore, supply evidence of a greater incidence of plague among women than among men. Not so decisive, but pointing in the same direction are the rest of the figures in the table given above, which refer to a number of smaller towns and to a group of villages in the Baroda State. It will be seen that—with an exception in the case of the small town of Kotri—the percentages of cases among women to the total plague cases ranged in the places in question from 42 per cent. upwards, averaging probably about 50 per cent., and reaching 58 per cent. in the case of Cutch Mandvi, a town of 38,000 inhabitants. The high percentage among women in the case of Cutch I. 352 Mandvi is so striking a phenomena, that it has been suggested in explanation that it must have been due to the flight of more men than women from the infected town. With regard to this particular point there is, however, no exact information available. Returning, therefore, to the inferences that may be drawn from the figures relating to the whole series of small towns and villages, it would seem probable—even making allowance for a certain excess in the female population of small places over the percentage 47·9, which was in 1891 the percentage of females in the total population of India—that the percentage of plague cases among women has been quite as great as the percentage of plague cases among men.

Conclusions regarding the relation between sex and liability to plague.

298. We may now sum up our conclusions regarding the statistics which we have considered in the last two paragraphs. We may reject the figures for Bombay and Calcutta, as so vitiated by concealment of cases among women as to be useless as

indications of the respective liability to plague of men and women. The figures which are available for other places, as they stand, would seem to indicate that the percentage of cases among women is at least as great as the percentage of cases among men, and when we take into consideration the circumstance that the factor of concealment must in all cases to some extent have tended to decrease the number of cases recorded among women as compared with the number of cases recorded among men, we may conclude with probability that the percentage of cases among women has been greater than the percentage among men. Even if this conclusion were established beyond doubt, it would, however, be far from affording proof of any special susceptibility to plague attaching to women; for consideration will show that by reason of their more confined life women would more than men be exposed to the risk of contracting the disease from the infection lurking in infected houses, from which as we have seen the greatest number of plague cases originate.

X. (3). *Influence of Race on Liability to Plague.*

Influence of race on liability to plague.

299. We now pass on from the consideration of the influence which is exerted on liability to plague by sex to the influence which is exerted on liability to plague by race. In dealing with the influence of race, we may limit ourselves to discussing the question whether there is any difference of susceptibility between Europeans, Eurasians, and the natives of India collectively considered. The only statistical data which we were able to collect on this question are data relating to the City of Bombay and to the Civil and Military Station of Bangalore, which are the only two plague-infected places with a large population of Europeans for which figures are available. The facts with regard to the incidence of plague in Europeans, Eurasians, and Natives, respectively, are set forth in the following table :—

TABLE SHOWING INCIDENCE OF PLAGUE IN DIFFERENT RACES.

Place of Observation.	Period of Observation.	Authority for Figures.	Whether Figures refer to Cases of Deaths.	Rate per Mille among		
				Europeans.	Eurasians.	Natives of India.
Bombay - -	From the outbreak of plague to the end of 1896.	Lt.-Col. Weir, I.M.S., (Mr. Snow's Report, p. 152).	Deaths.	·08	·92	2·4
Bombay -	From the outbreak of plague to Feb. 1899.	Dr. Blaney, Evidence, 17,681–5.	„	1·06	7·30	Ranging from 15 p. c. (Native Christians) to 38·05 (Jains).
Bangalore Civil and Military Station.	From 15/9/98 to 28/2/99.	Mr. Cadell, Evidence, 25,015.	Cases.	3·6	18·4	42·5

It will be manifest, from a consideration of this table, that the incidence of plague has been very much less among Europeans than among Eurasians, and that it has been very much less among the Eurasians than it has among the Native Community. An impression has accordingly grown up in India that Europeans must possess something in the nature of a racial immunity against plague. But the extremely severe epidemics which have occurred in Europe in former times, and also the fact that one-half of the European population fell a victim to plague in the course of the epidemic which devastated Bombay in the 17th century, make it incredible that anything in the nature of a racial immunity comes into play. This inference is confirmed by the long record of plague cases which have occurred during the present epidemic among Europeans who were specially exposed to infection, and by the circumstance that the number of cases of plague occurring among Europeans in attendance in plague hospitals has not been less in proportion to their number than the plague cases that have occurred among native attendants. Again, it must be remembered that if a racial immunity is imputed to the Europeans, on the ground that they have suffered comparatively little from plague, it might, on this ground, be imputed also to the upper classes of the Parsees, for whom no such immunity has been claimed. We are of opinion that the relatively small incidence of plague among the European community (and the same would apply in a lesser degree to the Eurasian community and to some extent also to certain of the higher classes of natives) must be accounted for by the fact that the European is protected against wounds by his clothes, and particularly by his boots. Further, a great deal must, in the case of the educated classes, be claimed as the result of education, which secures that they shall not unnecessarily remain in contact with infection.

The President does not think that much weight can be given to these explanations. The former has, no doubt, been advanced by several of the witnesses; but, as it has just been stated, the case incidence in many European epidemics has often been extremely large, and the Europeans who suffered were well shod and even more heavily clothed than are the Europeans in India. The latter explanation appears to him inadequate to cover the many instances in which Europeans have in India been day after day in close relationship with infected persons and infected houses with almost complete immunity. The explanation which appears to him more probable has been stated in a separate Memorandum on the influence of insanitary conditions on plague. App. III. to this Report.

X.(4.) *Influence of Religion, regarded as an Index of varying conditions of life, on Liability to Plague.*

Influence of religion, regarded as index of habits, on liability to plague.

300. We may pass from the discussion of the question of the existence of a racial immunity to consider whether religion, prescribing as it may a particular code of habits, has had anything to do with liability to contract plague.

Para. 296 of this Report.

We have already, in the course of our discussion on the incidence of plague according to sex, printed a table which exhibits the rates of attack among different religious communities in Bombay. It will be seen, on referring to this table, that if we exclude the Lingaits (whose numbers are quite inconsiderable), the Jains show a rate of attack from plague which is double that of all other classes of the community. This high incidence of plague among the Jains is testified to also by Dr. Blaney. According to this witness, in three years the plague mortality among the Jains was 38 per mille, as contrasted with a mortality of 22·5 per mille among the other classes of Hindus, and with a much smaller mortality among the other classes of the community. Dr. Blaney spoke as follows with regard to this matter:—"The rate of mortality among the Jains, surprisingly large as it is, is real, and it is due to the fact that animal life is sacred among the Jains. They will not sweep their staircases, or sweep their sleeping rooms out, or their cooking rooms very often, lest they should destroy some animal life, so scrupulous are they. Only one half of the vegetables which are used by the natives of Bombay are eaten by these people, because animal life has been found in them. There are sundry other social peculiarities about them which render their sleeping-places and cooking places particularly susceptible to the attraction and preservation of the infection. Not that these places are very dirty. They are a wealthy people, and their places look comparatively clean." We are not precisely informed as to what is the nature of the social peculiarities spoken of by Dr. Blaney; possibly, however, the reference may be to the fact that the Jains, owing to their aversion to taking life, are said to be infested with parasites. They are also said to foster animals in their neighbourhood by providing them with food, and it is conceivable, therefore, that their houses are more rat-infested than those of the rest of the population.

17,681.

17,682.

When we pass from the case of the Jains, to consider whether there is any difference in the incidence of plague among the Hindus taken collectively, the Muhammadans, the Parsees, and Native Christians, we find that the more important data which are available for the resolution of this question can be presented in the form of a table. The table is as follows:—

TABLE SHOWING INCIDENCE OF PLAGUE IN NATIVES OF VARIOUS RELIGIOUS COMMUNITIES.

Place of Observation.	Period of Observation.	Authority for Figures.	Whether Figures refer to Cases or Deaths.	Rate per Mille among			
				Hindus.	Muhammadans.	Parsees.	Native Christians.
Bombay - -	From outbreak of plague to end of 1896.	Lt.-Col. Weir, I.M.S. (Snow's Report, p. 152).	Deaths	2·86	·98	1·41	2·36
Bombay - -	From outbreak of plague to end of February 1899.	Dr. Blaney, Evidence, 17,681–5.	"	From 20 per cent. (Brahmans) to 38·05 (Jains).	9·44	9·42	15
Baroda City -	From 1st October 1896 to 30th June 1898.	Evidence, 14,989; 15,219.	Cases	16	7·9	0	—
Surat - -	From 8th December 1896 to 11th March 1897.	Evidence, 15,633; 15,642.	Deaths	1·31	·39	1·87	—
Bangalore Civil and Military Station.	From 15th September 1898 to 28th February 1899.	Evidence, 25,015 -	"	45·5	36·5	—	40·5
Ankleshwar -	From April to November 1898.	Evidence, 14,448 -	Cases	33	24	38·3	0
Karachi City -	The period of the first Karachi epidemic.	Evidence, 11,827 -	"	45·4	40	9	?
Mysore City	From 1st October 1898 to 28th February 1899.	Evidence, 25,015 -	"	22·9	38·2	—	—

I. 352.
I. 349.
III. 459.
11,398, 27,041.
13,478–9,
15,632–4.

The figures given in this table for the different communities differ considerably in the different places. In the first six of the seven places for which statistics are set forth in the table, the incidence of plague among Hindus is recorded to have been greater than the incidence among the Muhammadans. The only town where the contrary has been recorded is Mysore City. An explanation of the smaller rates of attack recorded among Muhammadans suggests itself in connexion with the fact, already adverted to above, that plague cases among women are to a larger extent concealed in the case of the Muhammadan community. The contrary instance in Mysore is probably explained by the fact that, as there were no stringent plague measures applied in Mysore, there was nothing in this city to be achieved by concealment. Except for the circumstance that religion influences the recorded rate of attack among Muhammadans by engendering among them a desire to keep cases which occur among their women concealed, there would appear to be nothing in the habits and customs enjoined by the different religions which affects the plague incidence as exhibited in the statistics. It would, however, appear from the testimony of observers in many different parts of India that the fatality of plague is greater in the case of Hindu patients than in the case of Muhammadan patients. The difference may stand in relation to the robuster physique and better circumstances of the Muhammadan populations in question.

X.(5.) *Influence of Occupation on Liability to Plague.*

Liability to plague of traders who deal in grain.

Section VII.(4) of this Chapter. Para. 268 of this Report.

4980; 5501; 6414, 9702; 12,446–7, 12,486; 12,449, 12,451; 13,054, 13,059; 19,512; 24,529; 25,860.
6462, 12,596.
911.
11,197, 11,359.
16,316.
13,578, 14,693.
15,459.
14,448, 12,578, 12,597, 12,640.
23,608.

301. We have already, in connexion with the question of the importation of infection in merchandise, incidentally noticed the point that plague has in certain places broken out first among traders, and we have also, in connexion with the question of the spread of plague in an infected place, cited the opinion of Mr. Giles and Lieut.-Colonel McCloghry, I.M.S., with regard to the dissemination of the infection from Banniahs' shops. In proceeding now to inquire more in detail whether traders are specially liable to contract plague, or whether they exercise any special influence in disseminating the disease, we find that the only further facts and considerations which have a bearing on the question are the following. In Molagavelli, Kajurgi, Sirohi, Reri, Asu, in the case of the first and the second epidemics at Palanpur, further, in Ilkal and Jalgaon, and, lastly, in Poona in the third epidemic, the disease was in each case introduced by a trader who came into the place and there sickened of plague. Again, the first case that came under the notice of the authorities in Calcutta in 1898 was that of a small shopkeeper or hawker, and in Kotri also the first case was that of a Banniah. Moreover, in certain places plague appears to have broken out first among, or to have been most severe among, the merchants. This was the case in the Mandvi quarter of Bombay City, where the severe epidemic among rats was a noticeable feature of the outbreak. Here not only the Jains, many of whom are grain traders, but also the Banniahs, Bhatias, and Brahmans, of whom also many are engaged in the grain trade, were among the first to be attacked and suffered very severely from plague. The same was noticed also in the case of Karachi, where the first and second epidemics broke out among traders. In the second epidemic at Karachi, the Joria Bazar, which was occupied mainly by retail sellers of grain and other materials, was the first focus of infection and was the scene of one of the most severe rat epidemics on record. In Bulsar the first epidemic commenced in the street inhabited by grain sellers. In Nasik the disease occurred first among the grain sellers. In Baroda City plague first appeared in the grain market. In Ankleshwar and Kotri plague appears to have carried off most victims among the Banniahs. In Gadag, as we are told by Captain Colomb, seven out of a total of 12 cases which occurred in December 1898, occurred in Banniahs.

10,244, 13,422, 23,607.
3785–90, 3831–6, 11,430, 15,459, 15,471, 17,837, 22,645–6.

When we come to consider what may be the cause of the occurrence of the first cases among traders—here we have in view chiefly traders who have dealings in grain and and foodstuffs—and the greater prevalence of plague among them in certain places, several different explanations suggest themselves. In the first place, it is manifest that the superior liability of traders to contract plague may be attributed to the circumstance that the traders, since they travel more than any other class of the community, must more frequently visit infected places. Again, the fact that the traders necessarily come into contact with a large number of people immediately suggests that the greater prevalence of plague among traders may be due to their coming into contact in their places of business with infected persons. Lastly, the fact that the grain in which the traders deal is liable to have been contaminated by infection and is likely to attract rats to the places in which it is stored, may be invoked as an explanation of the prevalence of plague among traders and of the spread of plague in the neighbourhood of their shops. It is possible that each and all of these factors may come into consideration in connexion with the occurrence of plague in the trading community.

Classes other than traders likely to come specially into contact with infection.

302. In addition to the Banniahs and other traders, certain other classes of persons might be supposed to be particularly liable to come in contact with the infection of plague. The classes we have in view are, firstly, persons employed in the disinfection of plague-infected places; secondly, Dhobis, or washermen; thirdly, the Acharaj and the Domes and corpse bearers who assist in the laying out of dead bodies and in the carrying out of funeral ceremonies; and, lastly, scavengers and sweepers.

Liability to plague of persons employed in the disinfection of plague-infected houses.

303. Persons employed in the disinfection of plague-infected houses are, by the very nature of their employment, exposed to a greater risk of contracting the disease than persons who are not brought into direct contact with places which contain infective material. The frequent occurrence of plague cases among disinfectors is, therefore, a circumstance that we might naturally expect to come under observation. Indeed, the instances brought to our notice in which disinfectors were attacked are not few. The instances to which attention must here be more particularly directed, as affording the best indications of the amount of risk incurred by disinfectors in general, are those in which a number of plague cases has been observed to occur among the members of regular disinfecting gangs, and persons in close connexion with them. Such instances
are the following. In the North Western Provinces, out of 188 plague cases which 8929, 9178, 9217;
occurred in Jawalapur, Kankhal, and Jamalpur, 36 were cases of disinfectors, or of 9221; 9158.
persons connected with disinfection: such cases were very numerous in Jawalapur, where they amounted to 29 out of the total of 116 plague cases that occurred in the
course of the epidemic. In the Punjab, 50 cases out of a total of 3,407, were, it is 10,001, 9981.
estimated, cases of disinfectors, presumably including men employed regularly as disinfectors, and also those engaged on special occasions in the disinfection of their
own houses. In some of the Punjab villages, noticeably Mahlgahla, Khankhanan, 9987, 10,139,
Mallupota, and Bahrwal, cases among disinfectors were particularly numerous; but 10,349–51.
throughout the plague-infected villages of the Punjab, attacks among disinfectors were 10,143, 10,145–6.
common, and from a statement relating to 561 cases, which occurred in villages other 10,625.
than the four we have named above, it would appear that 21 of these cases were those of disinfectors. The conclusion arrived at by Captain James, I.M.S., from his
experience of plague work in the Punjab, was that "disinfection is the most dangerous 10,000.
work." Of the 100 cases that occurred in the second outbreak at Kotri, five cases 12,647.
were those of disinfectors. In Cutch Mandvi, eight out of the 300 disinfecting coolies
employed in the first epidemic were attacked: in the second epidemic there appear to 13,480.
have been cases among disinfectors, but particulars of their number were not supplied
to us. In Palanpur, Captain Rainier, I.M.S., said, after the return of the people to 13,100.
the City in the end of December 1897, seven or eight imported cases of plague occurred "chiefly among members of the disinfecting parties sent to the villages." In the
Hyderabad State it was noticed that many coolies engaged in disinfecting work I. 442.
contracted plague. Other instances were brought to our notice by Surgeon-General 220, 14,067.
Bainbridge and Mr. Edalji Bomanji Modi. Further, we were told that five out of 18,403.
20 coolies engaged in the disinfection of one particular temple at Sukkur were attacked.

The above facts are sufficient to prove that the risk of infection which is run by disinfectors is considerable. So serious is it that the question of adopting special precautions to lessen the risks which are incurred by disinfectors becomes one of the greatest practical importance. In connexion with this question the following cases are
of interest. Lieutenant Anderson made a statement before us, which was quoted and 22,668, 11,769.
confirmed by Mr. Kaka, that in Karachi, in a gang of from 50 to 55 disinfecting coolies, before inoculation was resorted to as a protective measure, 20 cases of plague
occurred, while no cases occurred after the inoculation of the gangs. A similar fact 10,681–6.
was observed by Captain Clarke, I.M.S., in the Hoshiarpur district of the Punjab; before the inoculation of disinfectors "cases had been occurring in the disinfecting gangs in every village that was being disinfected"; after inoculation was adopted, three cases only occurred, all among uninoculated persons in gangs that contained about
880 inoculated and 170 uninoculated persons. In Satara, we are told by Lieutenant 22,720–7.
Steen, the coolies, who during four months had been employed in disinfecting houses that had been left for three months vacant and partially unroofed, were free from plague; but when 24 coolies were employed in the disinfection of a small village only three weeks after its infection, seven of the coolies were attacked, and the coolies employed in other places also were attacked when they were careless, as in three small

10,907. wadis of Tasgaon, where four coolies died of plague. Similarly, in Surat, Mr. Judge found that his disinfecting coolies did not contract plague if they were careful, though they did so if they were careless, and he instanced the case of a carpenter who contracted the infection because he worked on the disinfection of houses with a cut upon his foot. These cases, while they too, like the cases first quoted, show that the risk which disinfectors run is great, show also that that risk can be practically removed by the taking of proper precautions.

Liability to plague of washermen 11,314.

304. With regard to the liability of washermen to contract plague, the following facts have been placed before us: An epidemic of plague occurred among a group of 70 washermen in Karachi, and after the removal of five persons who were sick at the time when plague was discovered among them, no other cases took place in this community. In Bombay, up to December 1896, out of a total of 1,838 deaths, which had been classified according to the occupations of the persons who had died, there were 19 deaths from plague (1 per cent. of the total) recorded among washermen. Between the 24th of September 1896 and the 10th February 1899, out of 4,000 patients treated in the Arthur Road Hospital in Bombay, 31 (0·75 per cent. of the total) were washermen. In Satara, out of 749 plague cases classified according to the occupations of the patients, four cases (0·5 per cent. of the total) are noted as having occurred among washermen. There was then apparently a considerable amount of plague among washermen.

I. 392–3. III. 466. 21,269.

Liability to plague of persons whose employment brings them into contact with persons sick or dead of plague, and their effects.

305. Next, as to persons whose employment brings them into contact with persons sick and dead of plague, and their effects.

Sections VI.(1) to VI.(4) of this Report. Para. 191 of this Report.

As to the liability of doctors and nurses and sick attendants generally to contract plague in the course of their attendance on the sick, a sufficiency of facts has already, in the section of this Report dealing with the infectivity of plague patients, been set down to allow of a judgment to be arrived at as to the amount of risk which is involved. Similarly, in connexion with the discussion of the incubation period, we have set down facts which show clearly that there is a considerable risk involved in making post-mortem examinations on persons who have died of plague. Further cases might also have been cited in this connexion, if details of these cases had been available. The risk of infection at post mortems, however, as will be seen on a study of the cases we have collected, is specially great in the case of unskilled attendants who fail to take the necessary precautions.

9459. Much less serious are the risks incurred by persons who are concerned in the laying out or disposal of the dead. We were, however, informed that, at Hardwar, a certain number of cases occurred among the Acharaj, who get the clothes of the dead. It is not certain that in these cases infection was derived from clothes, or from contact with the dead when assisting at funeral ceremonies; but we may note that Mr. Winter informed us that plague among the Acharaj ceased when precautions were taken to prevent the distribution of the clothes of the dead. 9271, 9460.

Liability to plague of sweepers and scavengers.

306. Passing to the question whether special risks attach to the occupation of sweepers and scavengers, we have not sufficient data to permit us to arrive at a definite decision. Isolated cases among sweepers are reported from two or three places in India; these may manifestly have been contracted in the ordinary course independently of the special occupation of the patients. On the other hand, the immunity of sweepers during the first epidemic at Bombay was so marked as especially to attract attention, and the suggestion was put forward that a certain amount of immunity was acquired by them in the course of their work, or that the plague bacillus was killed when it was introduced into dirt. 18,642. 1004.

X.(6.) *Influence of particular Habits of Natives of India on Liability to Plague.*

Influence on liability to plague of natives' habits.

307. Closely connected with the question of the special liability to contract plague attaching to particular occupations, is the question of the influence exerted on the spread of plague by certain native habits and practices. We may, before leaving this part of our subject, briefly refer to a few of these here.

(i.) Of sleeping on the floors;

First of the native practices which may conduce to the spread of the plague, and which may in part account for the much greater severity of plague among the natives as compared with the European community, is the fact that in many parts of the country it is the common practice for the natives sleep on the floor. It will be obvious that the absence of beds must not only conduce to the contamination of the floor by sick persons, but it must also bring the native more directly in contact with the floor, which may have been soiled by man or rats. The only specific observation which was brought under our notice in this connexion is one adduced by Lieut. Anderson. This witness had had under observation in Karachi a particular house where every inmate was attacked by plague, "except one who slept on the only bed." 22,655.

(ii.) Of going barefoot;

Another habit that probably conduces to the spread of plague is the custom which prevails everywhere in India among the natives of going barefoot, at any rate in the interior of their houses. The habit of going barefoot in houses may, we may assume, tend to increase the opportunity of contracting plague from contaminated floors, especially as cuts or abrasions are commonly to be found on the feet of natives.

(iii.) Of squatting on, and eating food off, the floor;

Further possibilities of contracting the disease from the floor are provided by the native habits of squatting on the floor, and by the habit, which would appear to be prevalent in certain places, of eating food directly from the floor. Mr. Dodgson saw food being eaten off a floor within a very few feet of a place where a plague patient was lying.

(iv.) Of cleaning brass vessels with earth.

The practice of cleaning out brass vessels with mud from the floors has also been noticed as a practice calculated to lead to accidental infection.

(v.) Of using earth-balls for certain cleansing purposes.

Lastly, the suggestion of possible infection by earth has also been made by Lieut.-Colonel Weir in Bombay, in connexion with the fact that a certain section of the community are in the habit of using earth balls in lieu of the ablutions which are customary elsewhere in India. 25,778.

XI.—EPIDEMIOLOGICAL QUESTIONS WHICH SUGGEST THEMSELVES IN CONNEXION WITH THE SPREAD OF PLAGUE.

XI.(A.) *Question as to whether a Prolonged Interval intervenes between the Importation of the Infection and the Outbreak of Plague in a Place.*

Opinion held by many observers that long interval usually intervenes between importation of infection and outbreak of epidemic.

308. Having in the foregoing sections of this Chapter set forth the main body of facts which bear on the spread and communication of plague, we have still to consider a series of epidemiological problems which arise in connexion with the spread of the disease. The first of these is the question as to whether a long interval occurs between the importation of the infection of plague and the outbreak of plague in an indigenous form. The opinion that such an interval usually does occur is held by a number of witnesses who came before us. Among these may be mentioned Surgeon-General Bainbridge, Surgeon-General with the Government of Bombay. "It seems," said this witness, "that between the date of the importation of plague into a town or village an interval of several weeks elapses before the disease becomes localised." 214. In the opinion of the witness, "the germs lay dormant for a time, or took some considerable period to acquire potency." Captain James, I.M.S., gave it as his experience that it was extremely common for a long period to elapse between the arrival of imported cases and the occurrence of the first indigenous cases in the infected villages of the Punjab. 10,223. Mr. Kabraji, the Acting Collector of Kaira, estimated that nearly three or four weeks elapse before an imported case gives rise to indigenous plague in a previously uninfected locality. 19,514. Dr. Simond, in a paper already referred to, and Mr. Hankin, in a paper on the spread of plague referred to in his evidence, have also discussed the question of the occurrence of an interval between the importation of the infection and the occurrence of local cases. Dr. Simond, in particular, asserts that it is a rule for an interval of 20 to 50 days to occur. Mr. Hankin expresses himself more guardedly; he considers that the question deserves careful attention.

Annales de l'Institut Pasteur, October, 1898. Annales de l'Institut Pasteur, November, 1898. 8564–5; 8632.

The question under discussion is a particular issue of a wider question.

309. Before dealing with the evidence which has been adduced by Dr. Simond and others in support of the theory we are now considering, it is important to realise that the question, as to whether an interval elapses between the importation and the spread of the infection, opens up only a particular case of the more general issue as to whether a prolonged interval may occur between a human case of plague and the human case next in series. This issue has already been incidentally considered in other forms.

In view of fact that long interval may occur between a human case and case next in series, interval may be expected also between importation of infection and outbreak of epidemic.

We have seen, when discussing the mode in which the plague bacillus may leave the infected organism, that, in the case of plague patients who convalesce with suppurating buboes or after developing pneumonic complications, the discharges are in certain cases capable of conveying the infection for weeks after all the patients have recovered their usual health.

Again, we have seen, in discussing the infectivity of houses and clothes (and we shall deal more fully with this question in connexion with disinfection), that the infective material may lie dormant in houses and clothes for prolonged periods.

Paras. 212, 219–20, 225–6 184–6, 220, and 659 of this Report.

Lastly, we have seen, in the course of our discussion of the mode in which the plague bacillus effects an entrance into the organism, and also of the infectivity of houses infected by rats, that the plague bacillus may be transmitted from animal to animal through a series of generations without the intervention of any human case.

The circumstances to which we have just referred show that it is quite possible for a prolonged interval to occur between a human case of plague and the human case next in series.

We may go further. There are other circumstances which suggest that the intervention of a prolonged period between two human cases may not be very infrequent. We have here in view the circumstance that the bacteria in cases of bubonic plague escape, from the infected organism only in very small numbers, remaining alive outside the body for a considerable period. It may thus, on the doctrine of chances, be expected that a considerable interval will, in many cases, elapse between the time when the bacillus leaves the body and the time when it comes in contact with another human organism in such a way as to give origin to an attack of plague.

In view of the above considerations, which apply generally, it is *à priori* to be expected that cases will be met with in which an interval will occur between the importation and the spread of the infection.

Instances of intervals observed by Captain James, I.M.S., in the Punjab.

310. We are now in a position to consider the instances in which a prolonged
period is said to have intervened between the importation and the spread of infection.
Captain James, I.M.S , furnished us with the following instances. In the case of
Khatkar Kalan, the very first village which was infected in the Punjab, the infection
appears to have been brought by one Ram Saran, who died on the day of his arrival in
9919-30. the village on the 29th of April, 1897. During the next two months no case of
suspicious illness was observed in the village; but from July onwards isolated suspicious
deaths began to occur. In October the deaths became so frequent as to cause alarm;
the matter came to the knowledge of the authorities, and the disease was recognised
as plague. All inquiries failed to trace any possible channel of infection other than
that mentioned above. It would thus seem that the introduction of plague must have
been due to Ram Saran, and that an interval of at least two months must have
occurred between his death and the infection of the next patient in series.—The
10,224 village of Aur furnishes another instance in point. On the 5th of April 1898, a
case of plague occurred at Aur, which was some miles distant from any infected
village. No other cases occurred, and the village was officially declared free from
10,549-51. plague on the 19th of April. On the 23rd or 24th of July, four mild cases of plague
were discovered, no external source of infection being traceable.—In the case of
10,099-01, 10,224. Gobindpur the disease was imported by a resident of the village, a boy who went
to see a friend at an infected village. On his return in the first week of March,
1898, this boy fell ill of plague. The attack was not a serious one. The next patient
was a man who lived next door. He died on the 14th of April. In this case the
interval between the attack of the person who imported the infection and the first
9987, 10,196, local case was 37 days.—In Mahlgahla the history of the outbreak was as follows. A
10,348. girl arrived from the infected village of Mallupota on the 12th of February, and she
remained well till the 22nd of February. She then fell ill, and was on examination
by an English doctor certified to be suffering from plague. She made a rapid and
uneventful recovery. There was no other case in the village till the 15th of March,
10,091. 21 days after the original attack.—In the case of Dahan, clothes were brought into
10,224. the village from Mallupota on the 12th of February, and were deposited in the house
10,224 and Capt. of a woman. This woman was attacked by plague 23 days afterwards.—In Laroya the
James' Report. first plague case occurred in the person of a man who had been in the infected village
of Piragpur. We are not told whether the patient recovered or died. The next case in
Do. series was that of his wife, who was attacked 26 days after his attack.—In Jhingran
the first case was that of a woman who had been on a visit to an infected village.
Do. The second case was attacked 25 days after the first.—In the case of Birampur, in the
Hoshiarpur district, plague was imported from Khatkar Kalan by a woman who had
been on a visit to the latter place, and who, returning to her own village on the 20th
of October, 1897, died there a few days afterwards. The next person attacked was
her mother, who fell ill on the 5th of November; the third case did not occur till
Do. December.—At Hansaron the first case is stated to have occurred on the 14th of March,
Do and the second case on the 13th of April.—At Masani the first patient died of plague
on the 27th of February, 1898, and the second on the 3rd of March. There was then
no further case till the 27th of March, when the wife of a man who was employed
in disinfecting the house of the second victim was attacked.—In the case of Bhaura

10,224 and Captain James' Report.

also there was, as we were told by Captain James, a long interval, but the exact dates were not available.—In the village of Aujla, a case, which was suspected of being a case of plague, was followed, after an interval of a month during which no cases occurred, by a typical case of plague.

When we consider these instances which have been adduced by Captain James, we see that they include the cases of twelve out of a total of 63 villages where the history of the importation was traced. In other words, a prolonged interval intervened between the importation of infection and the outbreak of plague in the case of the villages in the Punjab in less than one out of five cases. It is possible that the proportion of cases in which a true interval intervened between the importation of infection and the outbreak of plague was somewhat less than this, for although the history of infection was in each case very carefully investigated, and although the infected villages were cordoned, we must not overlook the possibility that, in some of the villages in which an interval apparently occurred, there may have been some undetected re-importation of the infection. If this were the case, the fact that a considerable period elapsed between the first and the subsequent cases of plague could obviously not be adduced as evidence to establish the existence of an interval between the importation and the spread of infection. Again, in certain villages, such, for instance, as Aur and Gobindpur, where the first patients recovered, it seems to us possible that the plague bacillus may have persisted in the organism of the first patient for a long period after convalescence, and that the first patient directly infected the next. If this was so, there would in these villages be no question of a real interval between the first and second cases of plague. Even, however, making allowance for possibilities such as those just mentioned, it would seem justifiable to conclude that, in at least a certain number of the cases cited by Captain James, a long period actually did intervene between the importation and the spread of the infection. In particular, the occurrence of such an interval appears to be established in the case of Khatkar Kalan, in the case of Dahan, and in the case of Masani.

We have no means of ascertaining how the interval in question was bridged over in the case of Khatkar Kalan; in the case of Dahan we may presume that the infection lay dormant in clothes; and in the case of Masani that it persisted in the house. In none of the twelve cases cited is there reason to believe that the interval was bridged by an epidemic of plague among rats.

Instances of intervals observed by Mr. Kabraji in Bombay Presidency.

311. Mr. Kabraji, the Acting Collector at Kaira, who seems to have paid considerable attention to the question here under consideration, gives us the following examples of the occurrence of a prolonged interval between the importation of infection and the occurrence of indigenous plague. The first case cited by him is that of Igatpuri. Some Muhammadans came from Bombay to Igatpuri, and a death from plague in the latter place 19,509. occurred among them on the 21st of July 1898. After an interval of nearly twelve days certain further deaths from plague took place in the locality. In this instance, the actual interval was not more precisely stated in Mr. Kabraji's evidence.—This witness further cited the case of Ilkal. "On the 31st of July 1898, a Marwari 19,512. Banniah came from Hubli and died at Ilkal. That death passed unnoticed. Then the man he had been living with died on the 21st August, and his wife on the next day. That started the plague at Ilkal."—Mr. Kabraji further cited the case of 19,513. Bobleshwar, a large village in the Bijapur Taluka. In the course of an inspection of this village, which was recognised as being in imminent danger of infection, inasmuch as it was situated between two infected villages, "I came" said Mr. Kabraji, "upon a house where that very morning (17th December) a man had died, and I was informed that his wife had died in the same house on the 23rd November. After a great deal of cross-examination it was brought out that the woman had been to a funeral at Kakhindki, one of the infected villages in question (with which the people had declared that they had cut off all intercourse). Two days after her return she had died. . . . . I came to the conclusion that the husband had died of plague." The inference that this death was due to plague seems to win support from the fact that "in another house at the back of the first one, the wife of the occupant was absent, but was traced to her father's house and found to be feverish, and on the third day following she died, apparently of pneumonic plague. Two of the sons of the first case, as well as his brother, also developed plague (as pronounced by a Hospital Assistant) in quick succession."

The facts detailed in the instances of Ilkal and Bobleshwar seem to point to a certain interval having occurred between the first indigenous case and the imported case from which it was derived. There is no record of rats having died in the interval.

Instance of interval observed in the Hyderabad State.
5501.

312. A further interesting case was cited to us by Colonel Lawrie, I.M.S., and Mr. Stevens from the village of Kajurgi in the Hyderabad State. "A Banniah arrived in the house 45 days ago from Umarghi. He died of plague three days after his arrival. The people state that there was no other case of sickness in the house afterwards for 20 days. The whole of the Banniah's family there got plague one after the other, and the Banniah himself and eleven males, making with the first case from Umarghi thirteen in all, died. . . . . That was the clearest case of a man coming from an infected district and dying, and there being a total absence of plague in the village for three weeks—twenty days clear. In that time it seems to have got exceedingly virulent, because the whole family were wiped out, including servants. All that remained were the old grandmother, the wife of the first man who died, and two small children." Mr. Stevens was positive that no dead rats had come under observation in that village.

Historical evidence adduced by Mr. Hankin in support of theory of interval.
Annales de l'Institut Pasteur, November, 1898, pp. 753–4.

313. Mr. Hankin, in his paper already referred to, first proceeds, with regard to the outbreak of plague in London in 1665, and with regard to the outbreak of plague in Marseilles in 1720, to adduce historical evidence tending to prove that in the case of both these two epidemics nine and six weeks respectively intervened between the importation of infection and the outbreak of the disease. Of recent instances in India, Mr. Hankin discusses the history of the introduction of plague into Kankhal, Satara, and Hubli, and he concludes that in each of these cases a considerable interval elapsed between the importation of infection and the beginning of the consequent epidemic.

Consideration of the Indian cases cited by Mr. Hankin in support of theory of interval.
Kankhal.
8914, 9065.
8916, 9077.
8774, 9074.
9253.
9080.
9290-3.

The history of the outbreak in Kankhal, which was given to us in detail by Mr. Winter, is a curious one. The last case of plague in the neighbouring city of Hardwar occurred in June, 1897. The only two cases of plague which had occurred in Kankhal up to that time were, first, the case of a beggar woman who had died in a garden, some little way out of the town, and, secondly, the case of Ram Kishan, a Hindu priest, who had contracted the infection at Hardwar and had died in Kankhal on the 16th of May. No other case of plague was discovered until the 16th of September, and it appears certain that no case of plague arrived in the town during that interval. In the middle of June it was reported that rats were dying at Kankhal. Bacteriological investigation showed that these were dying of plague. Careful inquiry was then made into all the deaths that had occurred in Kankhal since June. With reference to this inquiry, Mr. Winter, the Collector, remarked: "The number of deaths was very small; it was so small that one could inquire into the circumstances of each case. I traced suspicious cases back to the 3rd August, but before that I have no reason to suspect that there were any. None of the deaths before that date were connected with any of the deaths which occurred later on; they were not related to the people who died later on. They were mainly old people, or young people who would die in the ordinary course, whereas these special cases were very closely connected, and they died after very short illness. One of the Hospital Assistants or the Assistant Surgeon reported that a child had died of mumps. A person does not often die of mumps, and the probability was it was a case of plague. In another case a man had a bubo and had had leeches applied to him." Every one of these cases which were noted as suspicious occurred in the immediate neighbourhood of the house in which Kishan Ram had died. It is impossible, of course, to say for certain that there were no undetected cases of plague, but the inquiry made by Mr. Winter was evidently made very carefully and under very favourable circumstances, and it seems to us probable that no case of plague did occur during the two and a half months that elapsed between the importation of plague by Ram Kishan and the first indigenous case in Kankhal. It will be noticed that this interval, though it may have been bridged over in part by the transmission of the plague bacillus from rat to rat, was not entirely bridged over in this manner. No mortality from plague came under observation among rats subsequent to the month of June. There was thus an interval of about six weeks between the last date upon which dead rats were seen and the date of the first human case of plague.

Hubli.
Para. 61 of this Report.

The case of Hubli, which Mr. Hankin relied upon as another instance of a place where a long interval occurred between the importation of the infection and the outbreak of the disease, does not seem to us at all conclusive. We have already seen how uncertain is the history of the course of events at the beginning of the outbreak in Hubli. On the one hand, it is possible that there was a re-importation of the infection immediately before the severe epidemic in May 1898 occurred; on the other hand, it is possible that this epidemic was connected with the original importation of infection in October 1897 by a continuous series of sporadic plague cases.

Satara.
Annales de l'Institut Pasteur, Nov. 1898.

The third case cited by Mr. Hankin, that of the town of Satara, seems to us also very inconclusive; for, even taking the history exactly as it is set forth by Mr. Hankin, it would appear that during the interval of five weeks which elapsed between the first discovered indigenous cases of plague (which were found on the 3rd of October 1897) and the subsequent epidemic outbreak of plague in the neighbourhood of the first infected houses, a few cases of plague were occurring in the camps. There was, then, not a clear interval between the first cases of plague and the subsequent epidemic outbreak.

Evidence adduced by Dr. Simond in support of theory that interval occurs and is bridged by epidemic of plague among rats.
Loc. cit. p. 648.

314. We next pass to consider the instances adduced by Dr. Simond. Dr. Simond in his paper seeks to establish that it is the rule for a considerable interval to occur between the importation of the infection and the outbreak of the disease; he seeks, further, to establish that "the period of latency which separates the imported case of plague from the beginning of the human epidemic is the period which is necessary for the development of the disease among rats."

The evidence adduced by Dr. Simond on this question is of a two-fold character. First, with a view to establishing the existence of a prodromal or "incubation" period during which the disease spreads among the rats, Dr. Simond cites three specific instances.

Muska.
Loc. cit. p. 647.
General Gatacre's Report, p. 102.
II. 480.

He first cites the history of the outbreak of plague in the village of Muska in the Cutch State. The history of this outbreak was, according to Dr. Simond, as follows. A woman was infected in Muska in February 1897; another woman who assisted in nursing her caught the infection and conveyed it to her own family, ten members of which succumbed to plague. After these deaths (the dates of which are not given) had occurred, there were no further cases in the village till the 13th of May. We find certain further details with regard to Muska in a report by Lieut.-Colonel Wilkins, I.M.S., which is printed in General Gatacre's Report on the Plague in Bombay in 1896-7. The date of the original case does not seem to have been ascertained with accuracy. Lieut.-Colonel Wilkins writes: "About March last a few cases occurred in Muska." Referring to the cessation of the outbreak after the woman who had nursed the original case and ten other members of her family had died, he said: "Segregation and isolation stopped the plague there; no further cases occurred for a time." When the next case occurred, plague was raging at Cutch Mandvi. Muska is quite close to Cutch Mandvi, being less than 3 miles distant. Since thus there is a possibility of Muska having been reinfected in May from Cutch Mandvi, we think that the history does not warrant us here in concluding that there was a prolonged interval in Muska between the importation of the infection and the subsequent epidemic. But even assuming that we have a prolonged interval, it would appear that there was no epidemic among the rats. Major Hyde Cates' statement is quite definite on the subject; "the cases at Muska," he says "were certainly not due to rats."

Cherra and Woter.
Loc. cit. p. 647.

The only two other specific cases adduced by Dr. Simond are the cases of the villages of Cherra and Woter, which are both in the Karad Taluka of the Satara District. In the case of the first, Dr. Simond relates, citing the authority of Dr. Robertson, that there was an interval of "some weeks" between the importation of the infection and the subsequent cases. During this interval rats were found dead in the neighbourhood of the house where the first patient died. In the case of Woter, an interval of about a month is said to have occurred between the first group of cases and the subsequent case. No further details are given. In view of the fact that in the earlier stages of the outbreak in this neighbourhood no European officers were present, and that the means did not exist for collecting facts with accuracy, we do not think it is possible to be certain that there was, in these cases, a true interval between the importation and spread of the infection.

Waiving, however, this question, we think it is deserving of attention—seeing that the three cases given above are the only cases cited to establish the theory that the interval between importation and spread is bridged over by an epidemic of plague among rats —that only one of the three histories placed on record by Dr. Simond makes mention of a mortality of rats occurring in the interval between importation and the occurrence of indigenous plague. In short, Dr. Simond's theory, of the bridging over of the interval by an epidemic among rats, wins but little support from the particular cases cited by him.

Maps of the Bombay Presidency showing dates of importation and outbreak of plague.
Loc. cit. pp. 634-5.

315. With a view to establishing the general proposition that a prolonged interval regularly occurs between the first importation of the infection and the subsequent epidemic, Dr. Simond publishes in his paper two maps of the Bombay Presidency, on which there are inscribed, for each of the towns which had, at the date of the preparation of the maps, become infected, two dates, the first of these being the

date of the first imported case which was detected, and the second being the date on which the first indigenous case was detected. Dr. Simond appears to regard these dates, which are given on the authority of Major Grayfoot, I.M.S., as constituting conclusive evidence of the theory contended for by him that the infection of plague, when imported into a place, does not spread to man immediately, but spreads only after an "incubation period," during which the disease is propagated among rats. No evidence whatever is adduced by Dr. Simond in support of the tacit assumption that in the towns inscribed in his maps an epidemic among rats intervened between the first imported and the first indigenous case. Further, there is not in any of these cases any evidence to show that the first imported case recorded in the map was connected by any fact of causation with the first indigenous case. Now this cannot be assumed without proof,—first, because in the large majority, if not in all the towns inscribed on Dr. Simond's map, a considerable number of imported cases, any one of which might have given origin to the outbreak, came to light before a single indigenous case was detected; secondly, because the particular cases recorded as the first imported cases may, as has been explained elsewhere in the Report, have been cases which were detained at railway stations and which never entered the towns; and thirdly, because the plague outbreaks in many cases almost certainly originated from imported cases which did not come to the notice of the local authorities. The fallacies of the argument which is based by Dr. Simond upon the information supplied by Major Grayfoot are, therefore, much under-rated by this last witness when he told us: "To say the period between the first imported case and the first local case is the time it takes to make a place infected is not strictly accurate." Rather we may conclude that the dates set down in Dr. Simond's maps to establish that a prolonged period intervenes between the importation of the infection which originates an epidemic and the resulting outbreak of plague are, considered as evidence of the truth of that theory, entirely fallacious.

Para. 246 cf this Report.

17,135

Conclusions regarding occurrence of interval between importation of infection and consequent outbreak of plague.

316. To sum up, the facts adduced above suffice to establish that a prolonged period does in some cases intervene between the importation of infection and the outbreak of plague. We have, however, no reason for supposing that the occurrence of such an interval is anything but exceptional. When a true interval does occur between the importation of infection and a spread of plague consequent on this importation, we think that this interval is much more often bridged over by the persistence of the plague bacillus in the soil or in clothes, than by the propagation of the bacillus through a series of rats. While thus there is no element whatever of mystery attaching to the occurrence of this interval, we think that a knowledge of the possible occurrence of such an interval is of the utmost importance as indicating that the danger of the spread of plague cannot be regarded as over until a prolonged interval has elapsed after the last human case has come under observation.

XI.(B.) *Question as to whether Plague manifests itself at the Outset of Epidemics in Atypical Clinical Forms.*

Question whether plague manifests itself at the outset of an epidemic in atypical clinical forms.

317. The question which we now proceed to consider is whether plague manifests itself at the outset of epidemics in atypical clinical forms. This question is of great theoretical interest as bearing on the mode of origin of plague epidemics, and it has, at the same time, a practical importance in connexion with the difficulty which is not infrequently associated with the recognition of plague when it breaks out in a new place.

Prodromal epidemics of "mumps." 21,653–56.

Noteworthy in connexion with this question are the following observations. Assistant Surgeon Barucha remarked that in a village which had been under his observation an epidemic of "mumps," occurring in men, women, and children, preceded the outbreak of plague. This observer had a similar experience in Poona. Here, at the outbreak of the second epidemic, he had seen 20 to 25 children brought in from one house with symptoms of "mumps." In the case of one of these children symptoms of plague, among which was specified the occurrence of a bubo in the groin, afterwards presented themselves. We ourselves in Poona saw a case closely resembling "mumps" occurring in association with cases of plague. Again, at Kankhal, where, as already shown, a very strict watch was kept upon the mortality with a view to obtaining the earliest possible information of the appearance of plague, a case of death reported as due to the "mumps" occurred in close association with a series of suspicious deaths, which appear to have been the first cases of indigenous plague in the town. In another place, to wit, in the small town of Banga, in the Punjab, where Captain James, I.M.S., was on the watch with a view to detecting the first cases of plague that might

9077, 9253.

10,235.

occur, an epidemic of "mumps" occurring before the outbreak of plague "gave rise to anxiety." In Garshankar also an epidemic of buboes behind the ear is said to have 10,832. occurred before the outbreak of plague. While bacteriological data are in all these cases absent, it would seem possible that these prodromal epidemics may have been associated with an invasion of the glands in the neighbourhood of the mouth, nose, and throat, by an attenuated plague bacillus, which had previously been cultivating itself on the mucous membrane of those regions. We may bring into association with this the interesting observations made by Major Dimmock, I.M.S., in Bombay. 20,394. "A group of Parsees," he said, "came in from Thana, and the children were suffering 20,532. from nasal catarrh of a most severe type. The symptoms were, apparently, very acute—coryza, with a high temperature. There was no glandular enlargement in the early stages, but, subsequently, the mucous membrane of the nose and of the pharynx swelled up to a tremendous degree. Eventually, the lymphoid tissue became infected in the same way and the patients apparently died rather suddenly, of suffocation, within three or four days—in the severe cases. I took three of the children to Professor Haffkine's laboratory, and he investigated the cases most carefully, and finally decided that he could find no evidence of their being plague. At first I thought they were some peculiar cases of diphtheria, but diphtheria is not very common. It does occur during the rainy season, but even then it is not very common. The cases then passed out of my sight—they came to the out-patient department of my hospital and passed out of my sight and went to reside in Mazagaon. From the Health Officer, Dr. Weir, I understand that they set up a very severe epidemic in that region—that they were a focus of a severe epidemic of plague in Mazagaon."

In connexion with the difficulty of differential diagnosis between mumps and certain clinical forms of plague, we may refer here also to the fact that in the case of one inoculated man in the Byculla Jail at Bombay, and in the case of two inoculated III. 659 (*f*) men in the Umarkhadi Jail in the same City, the symptoms were such as to render it I. 9; 7236–8. doubtful whether the men in question suffered from plague or mumps. The same difficulty appears to have arisen in some other instances. Captain Walton, I.M.S., Captain James' in particular, drew attention to the difficulty of diagnosing cases at the beginning and Report, p. 166. end of an epidemic, instancing a case which could be diagnosed as mumps only by observation of subsequent cases arising in connexion with it.

General question of the occurrence of cases of pestis minor at the outset of epidemics.

318. With regard to the wider issue, as to whether it was the rule for a larger percentage of cases of pestis minor to come under observation at the outset as compared with the other phases of plague epidemics, very little exact information is at our disposal. In addition to the cases quoted above, in which epidemics appear to have begun with the milder forms of plague, only one isolated instance has been brought before us in which an outbreak appears to have begun with cases of pestis minor. This is the instance of the outbreak in Hyderabad, Sind. Here, as we are told by 18,102. Lieut.-Col. Henderson, I.M.S., mild cases were more frequently observed at the beginning of the epidemic. In adverting to this as the only definite case brought directly to our notice in India, we are not unmindful of the fact that Professor Simpson, who was at the time we have in view Medical Officer of Health for Calcutta, is of opinion that a succession of mild cases of bubonic disease in 1896 preceded the occurrence of genuine cases of plague in that City. On careful consideration, however, Paras. 95 and 156 of all the evidence that was laid before us in this connexion, we think that there is no of this Report. reason to suppose that any of the cases which were regarded by Dr. Simpson as cases of pestis minor were genuine cases of plague. In particular, the cases of indolent climatic buboes occurring among the British troops, which were specially noted by Professor Simpson, appear to us to have stood in no connexion at all either with the fact that the Shropshire Regiment had previously been engaged on plague duties in Hong Kong, or with the fact that plague afterwards broke out in Calcutta. The bacteriological evidence which was regarded as establishing that these cases of indolent bubo were cases of pestis minor seems to us to have been fallacious.

Plague epidemics heralded by increased mortality from pulmonary diseases.

319. In certain cases the advent of a plague epidemic has been heralded by increased mortality from diseases of the respiratory system. Such an increased mortality was a noticeable feature in the months which preceded the first plague epidemic in Bombay. So noticeable was this increased mortality, that Captain Childe, I.M.S., made a special investigation of its causes, in the course of which he established I. 375. by bacteriological methods of proof that plague may manifest itself in the form of plague pneumonia. In Poona also, antecedent to the outbreak of the third epidemic, 21,790; 21,918–9. an increased mortality from pulmonary diseases came under observation. The data with regard to Poona are in so far more definite as corpse inspection was being

regularly carried out in the town, with a view to determining the cause of each death. We learn from the statistical records, which embody the results of these inquiries, that the deaths from diseases of the respiratory system, which had in the months of October, November, and December, 1898, amounted to an average of 99 cases per month, increased to 172 in January, 1899, this being the month which immediately preceded the outbreak of the third epidemic of plague.

21,416.

21,788.

The occurrence of an increased mortality from pulmonary diseases at the commencement of a plague epidemic is not a new observation. We find attention already directed to the matter in a paper by Thomas Whyte, Esquire, published in the "Transactions of the Bombay Medical and Physical Society," for 1838. "On its first visitation," says the observer in question, speaking of the outbreak of plague in Kathiawar in 1820, "that form (of plague) noticed above, as distinguished by fever, slight cough, pain in the chest, and hæmorrhage, has been the most common, but it has disappeared for some time. This variety seems to have appeared first at every place which has yet been visited." Mr. Whyte notes in this connexion the fact, already referred to, that plague at Athens appears to have been ushered in by an epidemic of a fatal form of pulmonary disease. In de Chauliac's *Chirurgia Magna*, already quoted by several authors in connexion with the general history of Plague, there occurs the following passage: "But the mortality"—the author is speaking of the epidemic of plague in Avignon in A.D. 1348—"began among us in the month of January, and lasted for seven months, and presented two types. The first lasted for two months with continued fever and spitting of blood, and these died within three days. The second lasted for the rest of the time, also with continued fever, and apostems and carbuncles on the external parts, especially in the axillæ, armpits, and groins; and they died within five days. And it was so contagious, especially when it was attended by spitting of blood, that not merely by living with the patient, but even by looking at him, one person caught it from another." To return to the case of Bombay and Poona, it would appear to be probable that the increased mortality from pulmonary disease, which was here observed anterior to the outbreak of definite plague, was referable, not so much to typical pneumonic plague, as to the occurrence of cases of mixed infection in which the plague bacillus played only a secondary rôle, the primary rôle being played either by the tubercle or the influenza bacillus, or by the pneumo-coccus.

Occurrence of the septicæmic form of plague at the outset of an epidemic.

Para. 368 of this Report.

Appendix XXV. in Vol. II. of these Proceedings.

320. In certain places plague has manifested itself at the outset only in a septicæmic form, buboes appearing, as is the rule in septicæmic cases, only where the disease ran a favourable course, and then in the later stages of the disease. This mode of origin of a plague epidemic has come under observation particularly in connexion with the plague outbreaks in the regions of Kumaun and Garhwal, where the disease is, as we shall see, endemic. It was, as we learn from a study of Surgeon-General Planck's record of a large series of village epidemics in these regions, the exception rather than the rule for plague to appear at the outset in the typical bubonic form; in most cases, the symptoms of the disease as first observed were those merely of high fever, followed shortly afterwards by the death of the patient. The typical bubonic form generally made its appearance only after the occurrence of a succession of such septicæmic cases. It is hardly necessary to point out that, when an epidemic of plague begins with a succession of septicæmic cases, the character of the disease may readily be mistaken, unless bacteriological examination is resorted to.

Causes which may determine the clinical type with which plague epidemics commence.

321. It may be profitable, in conclusion, briefly to consider the possible causes which may determine the particular clinical type in which plague appears at the outset of an epidemic. When, as ordinarily has been the case in India, the disease has been introduced by the importation of a human plague case from outside, and when the first indigenous case or cases have followed without any very considerable interval upon the escape of the plague bacilli from the body of the patient who gives origin to the subsequent outbreak, the disease may reasonably be expected to manifest itself in exactly the same guise as in the case from which the infection has been derived. In other words, the disease may be expected to manifest itself either in the ordinary bubonic or in the pneumonic or septicæmic type, according as the original patient may have suffered from the one or the other of these forms of plague. Where, on the contrary, there has been a break in continuity,—where, in other words, the virulence of the infective agent has either been diminished or exalted after its escape from the human organism,—it is comprehensible that the disease might at the outset manifest itself in an altered clinical form. It would, for instance, be intelligible that where the action of prolonged desiccation had come into play, the plague bacillus should be attenuated, and that it should manifest its effects at the outset in a less virulent

type of attack. Possibly the comparative mildness of many of the cases observed in Oporto and Glasgow may admit of such an explanation. Again, where the plague bacillus finds conditions for growth which are favourable to the exaltation of its virulence for man, it is intelligible that plague should manifest itself at the outset in an unusually virulent form. It is interesting to note in this connexion that, so far as can be gathered from the indications furnished in Surgeon-General Planck's Report, already referred to, the outbreaks of plague, which arose apart from an introduction of the infection *ab extra*, were almost uniformly associated with the occurrence of a preliminary series of septicæmic cases. The large majority of the particular village outbreaks in question, were, as we shall see, preceded by mortality among rats.

Para. 375 of this Report.

XI.(c.) *Question as to whether there is any Variation in the Fatality of Plague in different Phases of an Epidemic.*

Question as to whether there is any variation in the fatality of plague in different phases of an epidemic.

322. We may now, in following out the scheme set forth at the commencement of this Chapter, pass on to consider the question as to whether there is any variation in the case-mortality in the various phases of an epidemic – a question which is manifestly of considerable importance in connexion with the rise and decline of plague epidemics. Among the statistical data relating to this question which were furnished to us, by far the most important are contained in the detailed records which set forth the case-mortality from plague in the Arthur Road Hospital at Bombay for each monthly period from October 1896 to January 1899. We have in the chart printed on the following page plotted out for the period in question the curve of the variations in the hospital case-mortality, corrected by the omission of cases of convalescent patients transferred from other hospitals. With January 1899 our detailed record of case-mortality closes. We have, however, with the help of indications contained in a report by Dr. Choksi dealing with the subject of serum therapeutics, carried on the curve to April 1899. In the latter period, however, the case-mortality is to some extent influenced by the results of the treatment. For the purposes of comparison we have also set forth, for the period in question, the curve of the rise and fall of the total mortality in Bombay City, that mortality affording the most trustworthy indications of the course of the successive epidemics.

Records of case-mortality of the Arthur Road Hospital at Bombay.

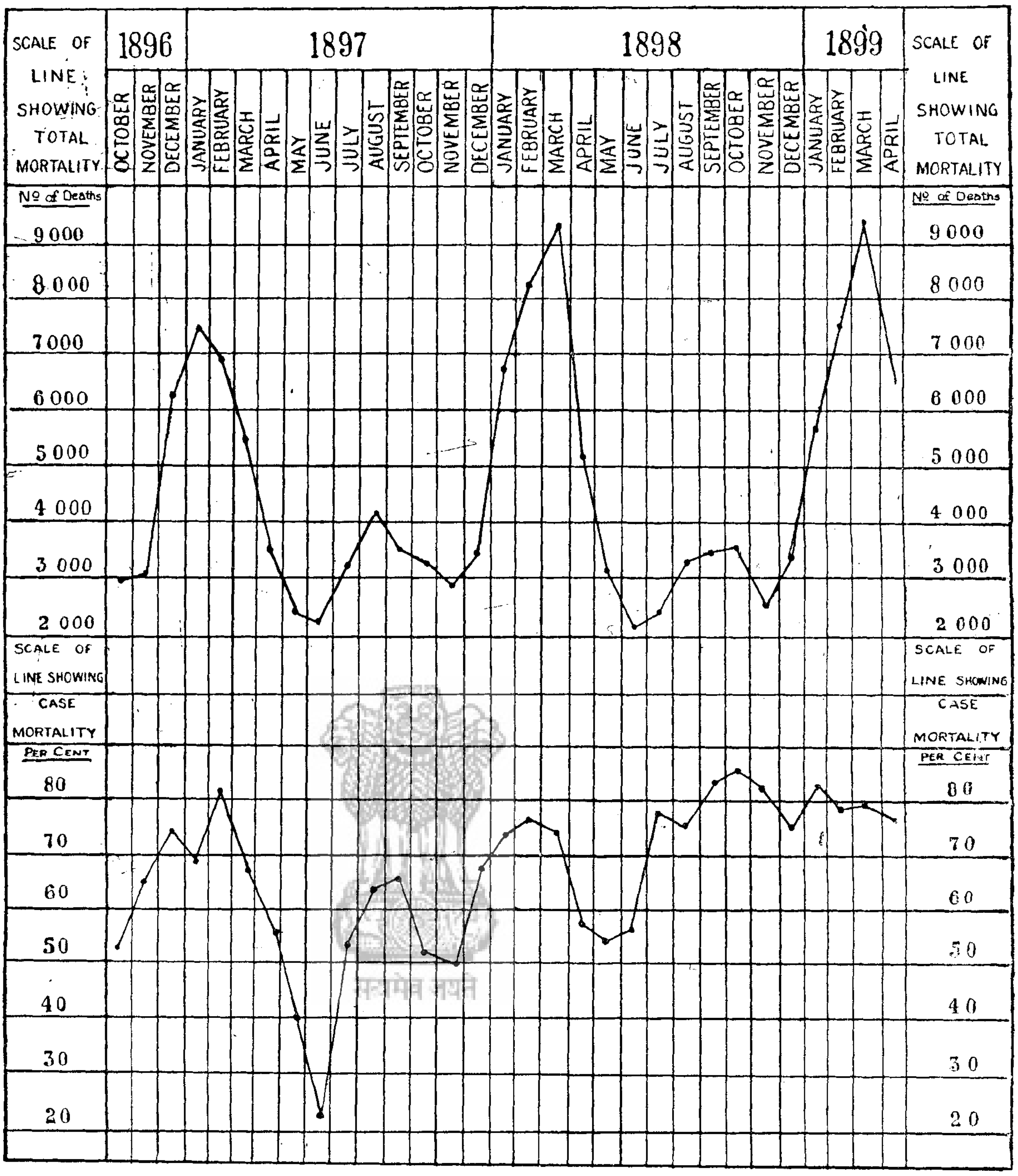
II, 457.

III. 461.

On consideration of the chart, it will be seen that in each successive epidemic the curve of the case-mortality shows a very close agreement with the curve which represents the rise and fall of the epidemic. Thus, in October 1896, at the outset of the first epidemic of 1896–7, the case-mortality stood at a little over 50 per cent.; it rose to over 80 per cent. at the climax of the epidemic, and fell off to a little over 20 per cent. at the end of the epidemic in June 1897. With the recrudescence of plague in July and August 1897, the case-mortality again rose and then sank again until it reached 50 per cent. in November, when plague once more was at a minimum. In the case of the epidemic of 1897–8, the coincidence between the two curves is equally close. The same thing holds true of the recrudescence which occurred towards the end of the rains in 1898 and ended in November, except that the curve of the case-mortality here started from a higher base line, and did not at any time reach a very low level. From November onwards to the month of January 1899 another, but a small, rise in case-mortality marks the beginning of the epidemic of 1898–9. The case-mortality in January reached the high figure of 80 per cent., and it showed a tendency to fall when the epidemic began to subside.

The striking concurrence of the rise and fall of the case-mortality with the rise and fall of each of the successive plague epidemics which have occurred in Bombay City would appear to point clearly to the conclusion that the rise and fall of the case-mortality is connected by some fact of causation with the increase and decline in the spread of the plague. Beyond this we cannot, however, go, as we have no means of arriving at a decision as to which of the phenomena in question is cause, and which is consequence. It is, on the one hand, quite conceivable that the rise and decline of a plague epidemic may depend upon a successive exaltation and attenuation of the plague bacillus in its passage through a series of men and animals. Just as easily conceivable is it, on the other hand, that the successive acceleration and retardation, which must, concurrently with the rise and fall of the epidemic, take place in the transfer of the plague bacillus from the organism of an infected patient to the patient next in series, may, by affording in the one case a shorter, and, in the other case, a longer, interval for the action of desiccation to be brought into play on the bacillus outside the organism, condition a variation in the case-mortality in the different phases of an epidemic.

DIAGRAM showing TOTAL MONTHLY MORTALITY in BOMBAY CITY and the AVERAGE MONTHLY CASE-MORTALITY among PLAGUE PATIENTS in the ARTHUR ROAD HOSPITAL, BOMBAY.



Records of case-mortality from other large centres.

323. When we pass from the records of case-mortality relating to the Arthur Road Hospital, Bombay, to consider the records of case-mortality which have been furnished to us from other large centres of population, we realise that these are practically of no value, inasmuch as they are based, not upon observations in hospital, but upon reports of sickness and death collected from an unwilling population which endeavoured so far as possible to conceal the fact of the existence of plague among them. For this, among other reasons, we have here excluded from detailed consideration the records of case-mortality furnished to us in connexion with the epidemics of plague in Hubli, Bangalore, Calcutta, Surat, and other places. The general tenor of the information collected at one of these places—Belgaum—may, however, briefly be placed on record here, as exemplifying some of the sources of fallacy which complicate such statistics. In the first epidemic at Belgaum in December 1897 and January 1898, the case-mortality of plague, as deduced from the records for the town, works out at over 90 per cent. We are told that during this epidemic there was much panic and concealment, such sick persons as were able to move leaving the town in order to escape the plague measures; we have here a factor which may account for the high case-mortality deduced from the consideration of the records of attacks and deaths. In the second and more considerable epidemic of September, October, and

23,127-8.

23,135-40.

vember 1898, when we are assured there was very little concealment, the case-rtality, which according to the reports received at the outset of the epidemic stood 70 per cent., varied during the height of the epidemic between 70 and 80 per cent. ith regard to the case-mortality at the outset and decline of this epidemic, it may noted that, again according to the reports received, there was a slight rise in e-mortality at the outset, and that the decline of the epidemic was marked by a e of the case-mortality to 90 per cent. This last feature of the curve of case-rtality is, however, probably due to the carrying over of deaths from the month ich witnessed the great decline of the epidemic to the next monthly period, when ere were very few new cases.

Records from certain of the smaller towns.

Porbandar. II. 484.

Ankleshwar. 14,404.

Ilkal. 19,493.

Igatpuri. 19,493.

324. The records of case-mortality furnished from the smaller towns, where the gue attacks and deaths could be kept under better observation, are, it may be esumed, more trustworthy. Four of such records are available to us. In the case Porbandar in 1898, where a total of 465 attacks were recorded in a period of en months, the case-mortality rose from 66 per cent. at the outset of the epidemic May, to 84 per cent. in August; it then fell to 73 per cent. in October, after which ere were only four cases with two deaths. In the case of Ankleshwar we may it from consideration the figures which apply to months when cases were numbered ly by units, and consider only the records for July, August, and September 1898. n July, when the cases numbered 21, the case-mortality was equivalent to 52 per nt; in August, when the cases numbered 191, the case-mortality works out at 73 per nt; in September, when the cases numbered 103, the case-mortality works out at 5 per cent. When, however, we consult the detailed daily abstract of plague cases d deaths which is available in this case, and note that in many cases which ended tally the attacks were recorded in one month and the deaths in the next, we arrive a process of inference at a probable case-mortality of 52 per cent. for July, of per cent. for August, and of 69 per cent. for September. In the epidemic at Ilkal 1898, 284 plague cases were recorded. Of these, 31 cases occurred in September, 25 in October, and 28 in November. The case-mortality for September works out om the records as 63 per cent., that for October as 87 per cent., and that for ovember as 78 per cent. If, however, we make the corrections for the carrying over deaths which seem indicated by the abstract of daily attacks and deaths, we arrive case-mortalities of 74 per cent., 87 per cent., and 68 per cent. respectively for the ccessive months. At Igatpuri, in 1897, the plague epidemic covered a period of most exactly three months. There were 126 cases in the month of August, 298 cases September, and 86 cases in October. The case-mortality for the successive months orks out at 63 per cent., 87 per cent., and 78 per cent. respectively. There are, wever, as is manifest from consideration of the daily abstract of cases and deaths, nsiderable corrections to be applied for the carrying over of deaths. It is difficult say precisely what the numerical result of these corrections would be ; there is, wever, no doubt that the corrected curve of case-mortality would rise from a mparatively low figure at the outset of the epidemic, would reach a maximum at e climax of the epidemic, and would towards the termination of the epidemic ll off much more markedly than would appear from the record as it stands. Thus, all these small towns, the case-mortality rises and declines, as it does in Bombay, th the rise and fall of the plague epidemic.

Paras. 527 and 542 of this Report.

Lastly, we may note the fact that evidence of a great falling off in the case-rtality at the end of a local outbreak is incidentally supplied in the case of statistics ed in Chapter V. of this Report in connexion with the case-mortality of cases not ated with serum in Karachi and Bangalore.

Opinions of plague officers regarding severity of plague in different phases of an epidemic.

14,634, 14,667. 15,113. 15,907.

12,512.

325. If we pass now from statistical results and consider the experience of individual gue officers, we find that five out of the six witnesses who expressed an opinion this matter stated that they had noticed a diminution in the severity of cases curring towards the end of an epidemic. The witnesses in question are Lieut.-lonel Nariman, I.M.S., who was in medical charge of the plague operations in rat; Diwan Bahadur Samarth, whose observations were made in the City and lages of Baroda; Mr. Jadhav, the magistrate of the Naosari District of Baroda; . Deva and Mr. Cooper, who acquired their experience in the course of their dical duties in Porbandar and Ankleshwar respectively, two of the towns whose tistics have been discussed above. Lieut. Niblock, I.M.S., however, told us that Karachi plague cases were just as virulent during the subsidence, as in the ginning, of the epidemic.

Bacteriological observations pointing to possible diminution of virulence of plague bacillus during last phase of epidemic.
8519.
8669.

II. 45[illegible]8.

326. In conclusion, we may note here that Mr. Hankin observed, in the case of the cultures obtained by him at the end of the plague epidemic at Jawalapur, a distinct diminution in their virulence for animals, as compared with the virulence of the plague cultures obtained by him in Bombay. In association with this diminution of virulence, Mr. Hankin observed that the cultures obtained at the end of the epidemic at Jawalapur were less sticky than the Bombay cultures; the Jawalapur cultures, however, regained the characteristic of stickiness after having been passed through a series of four or five mice. Interesting as Mr. Hankin's observations are, we would note that we have no exact information as to the cases in Jawalapur from which the attenuated cultures were obtained. Apart from this, Mr. Hankin's observations lose a great deal of their value in the present connexion; for, on a study of the list of Jawalapur plague cases which was furnished to us by Mr. Winter, we find that the epidemic at Jawalapur was not characterised by any regular decline of the case-mortality towards its close, unless we can see indications of the diminution of the virulence of the disease in the circumstance that the three last cases, which occurred sporadically within the month subsequent to the close of the epidemic at the end of April, all ended in recovery.

XI.(D.) *Question as to whether there is any Inter-relation between Meteorological Variations and the Increase and Diminution of Plague Mortality.*

Total plague mortality in India exhibits marked seasonal variations.

327. A notable feature in the mortality from plague in India has been the fact that, in every place where the disease has established itself in a more or less continuous manner, plague epidemics have alternated with periods of freedom, or comparative freedom from plague. The periods of high and low plague mortality in the case of the places which have contributed most largely to the plague mortality in India have, in the main, synchronised, and synchronised so closely that the plague mortality for India, as a whole, shows a very remarkable and regular seasonal rise and fall. This will be seen by reference to the Chart on the opposite page, on which we have plotted out the curve of plague mortality for the four successive years which have elapsed since the introduction of plague into India. In the month of June, as will be seen, plague has in each year sunk away to a minimum, the plague mortality for the whole of India declining to considerably less than 500 per week, and in three of the years to which our chart relates to very considerably less than this. From June onwards, plague has in each year increased up to a maximum which has fallen on some date between the first week in October and the second week in November. This maximum, except in the case of the year 1900, has represented the absolute maximum of weekly plague mortality for the year. From this autumn maximum the plague mortality has then in each year declined to another minimum which has fallen between the last week of December and the last week of January. The minimum mortality at this period has not fallen below 1,100 per week. After sinking away to this winter minimum, the plague mortality has in each year increased to another maximum in March. We have thus two periods of maximum plague mortality which fall on or about the midsummer and midwinter solstices, and two periods of minimum plague mortality following upon the spring and winter equinoxes.

No salient features which distinguish the weather at periods of high plague mortality from the weather at periods of low plague mortality.

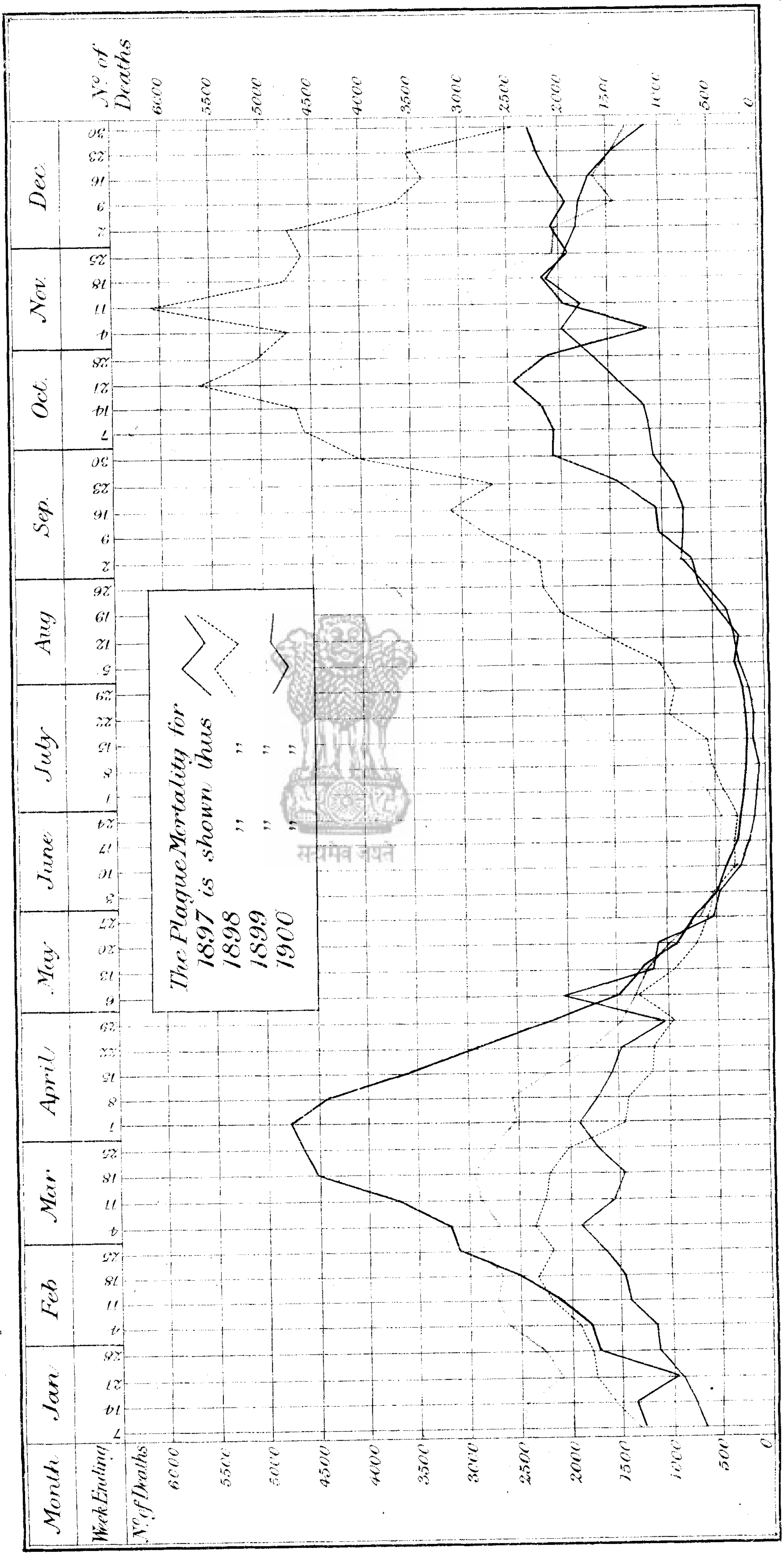
328. When we inquire as to what the meteorological variations are which correspond with the seasonal variations in plague mortality, we come face to face with the following facts. The atmospheric conditions at the period when plague reaches its absolute minimum are those associated with the commencement of the rains; in other words, the temperature is high and the air is saturated with moisture. Essentially similar are the atmospheric conditions when plague reaches it autumn maximum; the rains are not yet over and the air is still hot and moist. When plague has declined to its second minimum, the meteorological conditions are entirely different; the temperature has fallen and the air is relatively dry. Lastly, in March, when the second period of maximum mortality is reached, the weather is hot and the atmosphere is dry. We have thus, in India, two periods of greatest plague mortality, corresponding, the one with hot and moist, and the other with hot and dry, atmospheric conditions; and two periods of least plague mortality corresponding, the one with hot and moist, and the other with cold and dry, atmospheric conditions. It will be manifest, in view of thes facts, that there is no direct inter-relation between any particular type of weather an the period of highest and lowest plague mortality.

History of epidemics in particular places confirms conclusion

329. Confirmation of this conclusion is afforded by the study of the history c plague in many places, particularly in Poona and Karachi. For the two cities ju

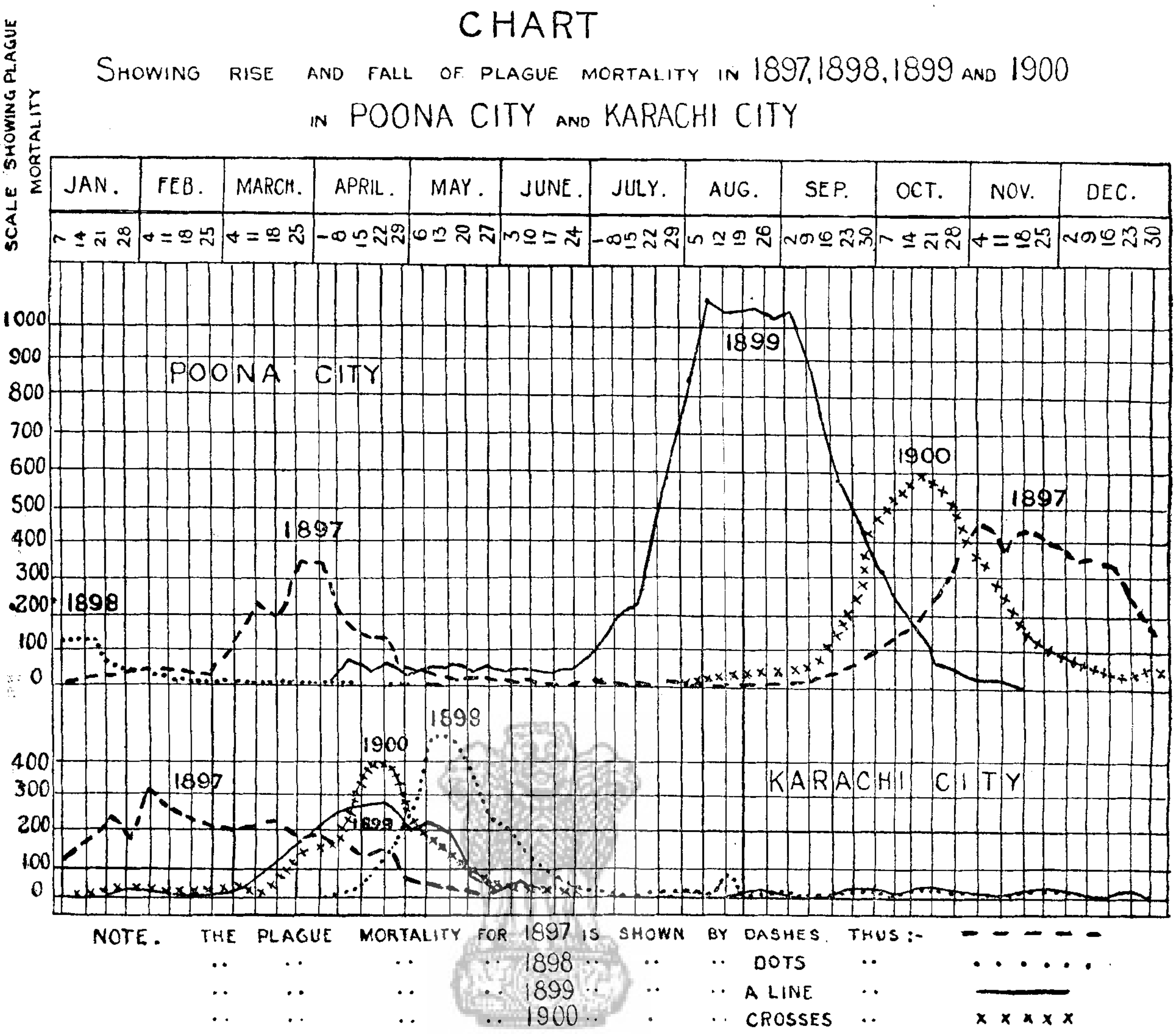
CHART

Showing Rise and Fall of Mortality from Plague throughout India in each Week during the Years 1897, 1898, 1899 and 1900.



that plague may be epidemic in all kinds of weather.

mentioned, we have plotted out the course of plague for the years 1897 to 1900 inclusive, in the following chart:—



सत्यमेव जयते

It will be seen on reference to the chart that plague has spread in an epidemic manner in Poona and Karachi under the most diverse meteorological conditions, the period of maximum plague mortality having fallen indifferently in periods of cold dry, hot dry, and hot moist, weather.

Influence of variations of temperature and humidity on prevalence of plague.

330. A few further points may be brought out in connexion with the general question of the influence of hot and dry, and moist and cold, atmospheric conditions upon the prevalence of plague in India.

In connexion with the influence of the first set of metereological conditions, we may draw attention to the following facts. Plague was epidemic in Sind in the very hot dry weather, the climax of the epidemic falling in March and April respectively in two successive years, 1897 and 1898. Again, plague, though it was introduced into the Punjab in the autumn of 1897, did not become epidemic till the spring of 1898, the climax falling in the very dry and hot month of May. Lastly, in the years 1897, 1899, and 1900, the plague was epidemic in the State of Cutch only in the hot dry weather.

In connexion with the question as to whether the general decline of plague in India in December stands in association with the colder, and in some places damper, atmospheric conditions prevalent at midwinter, we think it interesting to note that plague outbreaks not infrequently occur in Kumaun in the midst of ice and snow.

Prof. Hunter Stewart's opinion on the question.

Further, we would call attention to the fact that Professor Hunter Stewart, of the University of Edinburgh, who kindly undertook the critical examination of the meteorological data bearing on this question, arrived at the conclusions that: "In the areas affected by plague (1) the temperature conditions are suitable for the epidemic appearance of plague at all seasons, and (2) the amount of moisture in the atmosphere has little, if any, influence."

Detailed comparative records of meteorological variations and plague mortality available from certain places in India.

331. Before pursuing any further the consideration of the general question of the influence of the meteorological conditions upon the spread of plague, and in particular upon the length of time for which the bacillus of plague may survive outside the organism, we may, perhaps with advantage, pass in review such detailed comparative records of meteorological variations and plague mortality as are available from plague-infected places in India. We may deal first with the smaller places, and then proceed to consider the case of Bombay City.

Sirohi.
9902;
App. XXXII. in Vol. II. of our Proceedings.

In the case of the epidemic in the Sirohi State, we were furnished by Captain Grant, I.M.S., with a chart on which are set down the mean daily temperatures for the period covered by the epidemic and the number of plague cases which occurred daily. On a study of this chart, which is printed as Appendix XXXII. in Vol. II. of our Proceedings, it will appear that, with hardly an exception, a fall in the mean temperature was followed, in the course of a period varying from one to four days (*i.e.*, after an interval which may possibly represent the period of incubation), by a rise in the number of plague attacks. Similarly, each rise in the temperature appears to have been followed by a fall in the number of plague cases, while the final rise of temperature at the end of the chart was associated with the extinction of the epidemic. The interest of these particular observations is unfortunately diminished by the fact that they apply to an epidemic where the maximum number of cases did not on any day exceed seven. The meteorological observations made in Bangalore are, for an entirely different reason, almost devoid of interest. Here the variations in the temperature and humidity of the atmosphere were, in the period covered by the epidemic, quite insignificant. The figures relating to Baroda cannot be utilised here inasmuch as grave doubt as to the correctness of the plague mortality recorded is aroused by the fact that, after subtracting the plague mortality from the total mortality, the figures given indicate a mortality from causes other than plague which varies in the seven months to which the statistics relate from about 24 per mille to 120 per mille.

Bangalore.
App. LXXI. (iii.) in Vol. II. of our Proceedings.
Baroda.
15,238–46.

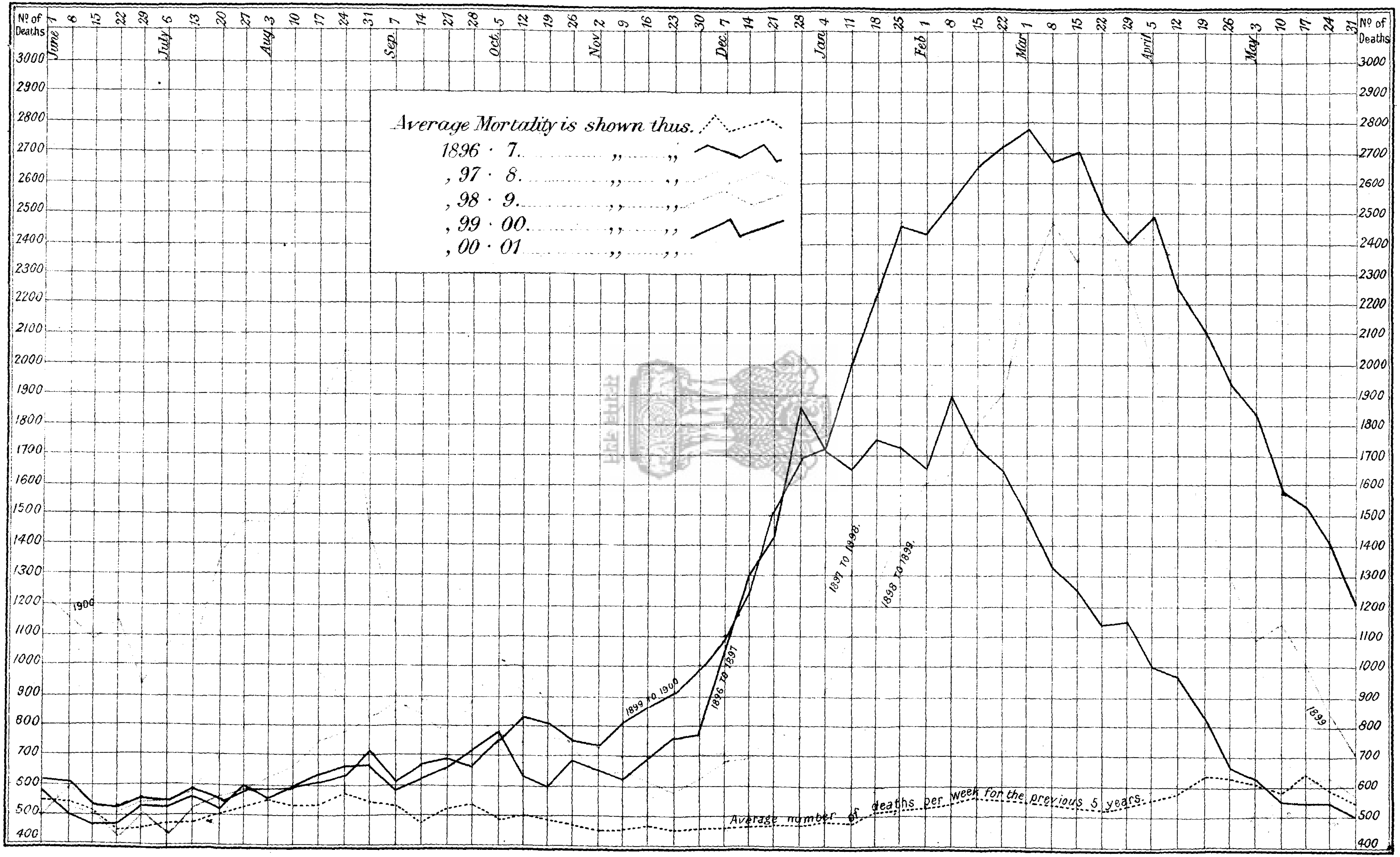
Seasonal variations observed in the different epidemics of plague in Bombay City.

332. We may pass now to consider the detailed records of plague mortality and meteorological variations which are available in the case of Bombay City. Here, as in the case of India generally, a very remarkable seasonal periodicity of plague has come under observation, as will be seen on reference to the charts of total mortality published in Volume III. of our Proceedings as Appendices Nos. LXXVII., LXXVIII., and LXXXIV. This last chart we have brought up to date and reproduced on the following page. It will be seen from this chart that, in each successive year since plague was introduced into Bombay, the weekly mortality of the City has risen in the early months of the cold weather, and has increased up to a maximum, which has fallen in 1897 in January, in 1898 in February, and in 1899 and 1900 early in March. After reaching its maximum, the weekly mortality has in each year fallen away rapidly, reaching a minimum in the month of June. At this period, except in the year 1900, the total weekly mortality has been only very slightly higher than the average weekly mortality for the City in the years anterior to the advent of plague. In the end of July or in the month of August the curve of mortality has in each year risen—most markedly in 1900, and in the other years to a less extent. The curve then sinks away towards a second minimum in the beginning of November.

Consideration of Mr. James' comparative chart of meteorological variations and plague mortality for Bombay City.

333. The most important data bearing on the question of the influence of meteorological variations on the plague mortality in Bombay will be found embodied in the chart printed as Appendix LXXVII., which was put in by Mr. James, the Drainage Engineer of Bombay. Upon this chart have been entered for each day, since the advent of plague to the end of May 1899, on the one hand, the total mortality for Bombay City, and on the other hand:—(*a*) the maximum and minimum temperature; (*b*) the degree of humidity of the atmosphere; (*c*) the amount of rainfall; (*d*) the velocity of the wind; and (*e*) certain data with regard to the presence and amount of cloud. On consideration of this chart, it will be seen that, although the annual curve of plague mortality coincides in a general way with the annual curve of the temperature, yet the correspondence is by no means a very close one. Even if we quite leave out of sight the relatively inconsiderable rise and fall of the curve of mortality between July and November in the years with which the chart deals, our attention cannot fail to be arrested by the higher range of temperatures which were associated with the climax of the second and third, as compared with the first annual epidemic. Whereas the climax of plague coincided in 1897 with minimum daily temperatures which ranged between 60° and 70° F., the corresponding temperatures during the

DIAGRAM, Shewing weekly Mortality in Bombay June, 1896 to Dec. 1900.



climax of plague in 1898 ranged from 65° to 70°, and in 1899 almost always between 70° and 80° F. The absence of correspondence which here emerges as between the annual curves of temperature and of plague mortality comes out in a much more distinct manner on a consideration of the daily and weekly variations. A study of the daily and weekly rise and fall of the temperature and mortality curves will show that it would be as easy to interpret the curves in the sense of a rise of temperature conditioning a rise in plague mortality as in the opposite sense. What holds true of the daily and weekly variations of temperature holds true, as the chart shows, also of the variations in humidity. If, therefore, the rise and fall of plague mortality is in reality dependent upon the meteorological variations, it seems quite clear that the inter-dependence must be a very indirect one.

Theories which have been put forward to account for the seasonal variation of plague in Bombay :—

334. A variety of theories has been put forward as to the cause of the seasonal variation of plague in Bombay. Among these the following are perhaps deserving of mention :—

(a) Suggestion that it may be due to seasonal variation in population.

(a) It has been suggested that the periodical increase in the incidence of plague is due to the fact that, at the period of the rising epidemic, new pabulum is provided for the plague bacillus by the arrival in Bombay of immigrants from uninfected centres. This theory, if it rests upon any foundation of fact at all, would appear to have a very limited sphere of application, for, as will be seen, on a study of Mr. James' Chart, printed as Appendix LXXVII., an exodus took place in each successive year when plague began to spread in an epidemic manner in the City. The diminution of the population was particularly well marked in the case of the first epidemic. Moreover, this theory would not account for the rise of plague mortality so noticeable in July and August in 1899 and 1900.

(b) Suggestion that it may be due to seasonal increase of plague among rats.

(b.) It has been suggested that the rise and fall of the plague mortality may depend upon a greater or less prevalence of plague among rats and the consequent greater or less dissemination of the infection through the agency of rats. In connexion with this theory it will suffice to note that it rests on casual impressions only, and not on any basis of systematic observations. Even if the seasonal periodicity of plague in Bombay were brought into association with a seasonal periodicity of plague among rats, the underlying causes of the observed seasonal variation would be still to seek.

(c) Suggestion that it may be due to variation in ground evaporation.

(c.) It has been suggested that the seasonal variation in plague in Bombay may be dependent upon the variation of the ground evaporation, which is conditioned by variation in the atmospheric condition.

20,276–20,309. App. LVIII. in Vol. III. of these Proceedings.

Mr. Moos, the Director of the Government Observatory in Bombay, has endeavoured to establish the existence of such an indirect association. He has ingeniously shown that when, in addition to the temperature and humidity of the atmosphere, certain data relating to the temperature of the soil are taken into consideration, and when upon the basis of these data the amount of ground evaporation is computed for a series of successive weekly periods, a curve is arrived at which shows an extremely striking correspondence with the curve of the total weekly mortality. As may be seen, on consideration of Mr. Moos' Chart B., printed in Appendix LVIII. in Volume III. of our Proceedings, the coincidence extends even to the smaller undulations of the curve, so much so that accidental association would appear to be excluded. When, however, we go into the methods which were employed by Mr. Moos in calculating out his curve of evaporation, we find the correspondence between the curve of evaporation and the curve of mortality somewhat less convincing, as to the existence of a close connexion between the amount of ground evaporation and the course of plague mortality. We learned in the course of our examination of Mr. Moos that the minor coincidences of the two curves, which appeal in such a forcible manner to the eye, represent the result arrived at by calculations from data selected upon a principle which seems to us to be open to criticism. Mr. Moos told us that he had selected as the basis of his calculations the particular series of ground temperatures taken at a depth of 5 feet, because the curve of evaporation which was deducible from these particular readings coincided most closely with the curve of mortality. In brief, we learned from Mr. Moos that if he had selected any other series of thermometric readings than those of this particular depth of 5 feet, the smaller correspondences between the curve of ground evaporation and the curve of plague mortality would have disappeared, though the general agreement between the two curves would still have been preserved. Another point in Mr. Moos' calculations which seems to us deserving of note relates to his assumption that there is a free interchange of vapour between the ground at considerable depths, such as that of

20,296.

20,298–30.

5 feet, and the air. We think that this assumption, though it might hold good in a calculation affecting only the broad features of the annual variation, could hardly hold good in calculations affecting the question of the vapour which would be given off from the ground in a daily or weekly period. We pass to a more general criticism. It appears to us that if Mr. Moos' theory of the causal association between the rise and fall of the curve of ground evaporation and the rise and fall of plague mortality furnishes a true explanation of the seasonal periodicity of plague in Bombay, the theory ought to be applicable also, in a general manner at least, to other places, but the fact that in many places severe plague epidemics have occurred in the rains, when ground evaporation is largely suspended, would seem to indicate that this factor, if it plays a part in determining the spread of plague, cannot in all places be a factor of prime importance. That the problem is far from clear, and that there are many difficulties in the matter will be apparent from the fact that Dr. Buchan, the Secretary of the Meteorological Society of Scotland, to whom we referred Mr. Moos' meteorological work for technical criticism, sums up his study of the evidence in the following terms: "This connexion between the curve of mortality and these temperatures' curves opens up a field of research to the physician and the bacteriologist, and the research is all the more likely to lead to good results when it is kept in mind that the principal maximum mortality of the year occurs when the weather is coldest and driest and the secondary maximum when the weather is moistest and wettest, and the temperature very high."

III., 437.

(*d*) Suggestion that it may be due to influence exerted by weather on habits of the people.
26,104.

(*d*.) Further, it has been suggested that the seasonal variation of plague in Bombay may be dependent upon the influence which cold weather exercises in driving the people into their houses at night. The possible importance of this factor as a means of spreading plague will be immediately appreciated when it is realised that an estimated number of 350,000 people (*i.e.*, a number equivalent to nearly a half of the normal population of Bombay) sleep, in the warm weather, in the open, and in the cold weather, in their houses. It may reasonably be assumed with regard to the inmates of plague-infected houses that these, when sleeping indoors, would be more exposed to the risk of infection. We have unfortunately no means of testing the actual effect of this factor by reference to exact observations. There is not in the case of Bombay anything in the nature of a trustworthy record of the daily plague attacks available, such as would enable us to judge of the influence exerted by a cold night. And though Mr. James' Chart shows in practically every case a rise in mortality as occurring within a few days after a cold night, the general character of the curves is so irregular, and there is so much uncertainty as to what interval would elapse between plague infection and death, that it is impossible to correlate any particular rise of mortality with an antecedent fall in the temperature. Thus, no definite conclusion can be arrived at as to the effect produced by the driving in of the population into their houses at night by the cold. It is, however, remarkable that the advent of the rains, though it must obviously drive the people into their houses at night, does not, in Bombay City, go hand in hand with any increase of plague.

(*e*) Suggestion that it may be due to longer or shorter survival of plague bacillus outside the organism.

(*e*.) Lastly, it has been suggested that the seasonal rise and fall of the plague mortality in Bombay may be directly or indirectly dependent on an influence exerted by seasonal meteorological variations on the survival, growth, or virulence, of the bacillus outside the animal organism.

This last theory we propose to consider in its relation to the wider question of the seasonal variation of plague in India generally.

Weather may influence plague indirectly by its effects on the human community; in particular, by confining people to their houses and interfering with plague measures.
13,485.
16,646.

335. Before dealing with the special question of the influence of meteorological conditions on the survival in a virulent form and eventual multiplication of the plague bacillus outside the body, we may emphasize the point, which has already emerged in connexion with Bombay City, that metereological conditions may, in some cases, determine the greater or less prevalence of plague by influencing the habits of life and activities of the human community. The fact that in the Sirohi State plague cases were more numerous after a cold night, and that the same was observed at Daman and Cutch Mandvi after the occurrence of a Scotch mist or a heavy dew at night, may possibly be explicable in this way. Again, we must bear in view that certain meteorological conditions—and we have in view here in particular the occurrence of heavy rains—may render all measures for the suppression of plague difficult or impossible to carry out. The heavy mortality which, as will be seen from the chart printed as Appendix LXVI. in Volume III. of our Proceedings, occurred in the Karad villages after the downpour of heavy rains, may very probably have been

due to the necessary suspension of the evacuation operations. In the same way the phenomenally high plague mortality which occurred in the Dharwar villages in the heavy rains, is probably accounted for by the suspension of evacuation proceedings. In harmony with this is the opinion expressed by Professor Hunter Stewart that "the rainfall seems to exert its effects chiefly or entirely by interfering with remedial measures."

1601, 2192, I. 92-3.

Influence exerted by meteorological conditions on the survival of plague bacillus.

336. A few words will dispose of what it is necessary to say here concerning the question of the possible influence of meteorological conditions on the vitality of the plague bacillus outside the organism.

Paras. 141 and 146 of this Report.

We have already seen, in a previous section, that the plague bacillus is capable of surviving exposure, on the one hand, to the winter frosts of Russia, and, on the other hand, to the tropical heats of a summer on the plains of India. It will thus appear that variations of temperature which occur in India generally, not to speak of those which occur in the equable climate of Bombay, could not of themselves directly affect the vitality of the plague bacillus.

Much more important, as we have seen, than the direct influence of temperature is the influence of temperature as determining a variation in the humidity of the atmosphere. In conformity with this it might have been supposed that plague would under damp atmospheric conditions everywhere spread in an epidemic manner, and that it would die out when the air became dry. This, however, as we have already seen, does not hold true. Not only has plague spread in an epidemic manner in the hot dry weather in some of the hottest and driest regions of India, but it has, taken generally, died out or decreased about the time of the advent of the rains. We can only explain this by supposing that the influence which atmospheric humidity exerts in the direction of favouring the survival of the plague bacillus in external nature must in very many cases be compensated for, and more than compensated for, by the increased multiplication of saprophytic bacteria which takes place in damp surroundings. It will be remembered that many of the common saprophytic bacteria exert an influence which is unfavourable to the survival and multiplication of the plague bacillus.

In connexion with the theory of the influence exerted by the ground evaporation, and in particular by the ground evaporation from a sewage impregnated soil, on the rise and decline of the plague mortality, we may immediately reject the idea that the ground evaporation could be directly responsible for the conveyance of the disease to man. Bacteria would under no circumstances be carried up by evaporating moisture. On the other hand, it is obvious that the evaporation of moisture from the soil might keep the earth floors of the lower storeys, and through them the atmosphere of the houses, continuously moist. It might thus, given that the other conditions were also favourable, operate in the direction of favouring the survival, or, as the case might be, the saprophytic growth, of the plague bacillus. Further it is just conceivable, in the light of Dr. Marsh's experiments, already referred to in this Chapter, that the ground air of a sewage-polluted soil, containing as it does appreciable quantities of carbonic acid gas, might, when it was carried up by the current of evaporating moisture, favour the saprophytic growth of the plague bacillus in the upper layers of the soil.

Para. 162 of this Report.

Certain other considerations relative to the influence of meteorological variations on the survival of the plague bacillus in a virulent condition outside the organism will more appropriately come up for discussion in connexion with the theory of acclimatisation.

Section XI.(G.) of this Chapter.

XI.(E.) *Question of the Influence of Insanitary Surroundings on the Spread and Persistence of Plague.*

Insanitary conditions which have been brought into association with plague.

337. Outbreaks of plague have in India, as elsewhere, often been brought into relation with the existence of insanitary conditions in and about the dwelling-houses. Among the conditions which have been brought into relation with plague in India are: overcrowding, absence of ventilation, damp, defective lighting of the dwelling-rooms, the character of the floor (this consisting in India for the most part of a mixture of earth and cow-dung), and, lastly, defective cleanliness, and, in particular, defective arrangements for the removal of the night soil. Among the conditions external to the houses which have been brought into relation with plague are: sewage pollution of the soil, excess of moisture—gauged by the high level of the subsoil water,—narrow streets, and a deficiency in open spaces. In short, every circumstance, excepting only the character of the food supply and of the drinking water, has been brought into relation with the prevalence of plague.

We purpose here to consider how far a causal association can be established between the various insanitary conditions which have been particularised above and the prevalence of plague.

XI.(E.)(1.) *Existing Conditions in India in connexion with Sanitation inside Dwelling-houses.*

1. Internal conditions.
I. (a) Existing conditions with regard to overcrowding.
25,667.

338. We may first consider the existing conditions with regard to overcrowding. All over India, and particularly in the towns, we have to deal with conditions of overcrowding. In the case of the City of Bombay, the degree of overcrowding may be judged from the fact there is in some of the wards one inhabitant to every 7·2 square yards of superficial ground space. At night the floor space in the large chawls in which the working population of Bombay is housed is, in the cold weather, when the people sleep indoors, covered with sleeping forms to such an extent that the floor is almost hidden from view.

I. (b) Existing conditions as regards ventilation.

339. Provision for ventilation can hardly be said to exist in ordinary native houses in India. In the ordinary sleeping rooms in the village houses there are no windows, and such sleeping rooms communicate with the exterior only through the intermediary of other rooms. In many cases cattle stalled within the house contribute to the vitiation of the atmosphere.

In the case of many of the overcrowded houses in towns (we have in view here particularly the chawls of Bombay), the conditions in the matter of the ventilation of the inhabited rooms are worse even than in the village houses. Not only is there less cubic space available proportionately to the number of persons accommodated within the limits of a single room, but there is, in the case of many of the rooms, a system of subdivision, by means of which each family is partitioned off from the others; in addition, purdahs, in the form of curtains or mats, are placed over all the doors to provide for the privacy of the women. And though windows are to be found in the large majority of the rooms, such windows look out in many cases upon dark and narrow gullies, and they are rarely opened. Again, the dwelling-rooms communicate with the exterior only by a system of low, narrow, passages. From this combination of circumstances, the condition of the atmosphere after the evening meal has been cooked in the rooms and the people have retired to sleep, with all the windows fastened, is more easily imagined than described.

If we seek for the reasons for this absence of ventilation from the native houses, we must bear in mind that the absence of windows and other openings in the walls is in conformity with the habits and attitude of mind of the native. Not only are draughts and ventilation of all kinds distasteful for their own sake, but—and this applies in particular to the village houses—the very presence of windows appears to be associated in the native mind with a sense of insecurity and with a sense of want of privacy. In the case of many of the large chawls in Bombay and other towns, an additional factor comes into consideration, this factor being the entire absence of sanitary supervision in the building of the houses. Even in the particular case of Bombay we ascertained that the Medical Officer of Health for the City can exercise no effective restraint on the erection of houses which have no means of ventilation.

I. (c) Existing conditions with regard to damp in the houses.

340. There is nothing special to be noticed about the condition of village houses in India with respect to damp. Speaking generally, inasmuch as the floor is raised above the surrounding ground, the houses are dry, except in the rainy season. An exception to this rule is, perhaps, to be found in the case of the houses, numerous in some parts of the country, where the cattle are stalled in the dwelling-house itself. Here we must assume that the atmosphere of the house may be frequently kept damp by moisture derived from the cattle. Especially must this be the case in the Kumaun and Garhwal districts (presently to be referred to as districts where plague is endemic). Here not only are the sleeping rooms purposely placed directly over the cattle stalls, so that in winter the warm exhalations of the cattle may come up through the chinks of the floor, but, in addition, the sleeping rooms are used also as store-rooms for the grain, which is, we are told, here brought in and stored in a moist condition in baskets.

II. 354 (209).
II. 360 (252).

In large towns we have to deal everywhere with the damp which is incidental to crowded houses; that is, with the damp associated with the exhalations from the cooking, and from the bodies of the numerous persons who inhabit the houses. In the particular case of Bombay we have, in addition, to deal with houses which are supplied with an unlimited water supply, which is both lavishly used and wasted by the natives.

I. (*d*) Existing conditions as regards lighting.

341. In a large part of India, the majority of native houses in villages are built without windows, and daylight obtains access to the interiors only through the doors. The sleeping rooms, opening as they almost always do off other rooms, are entirely dark. The reason of this is probably to be found not only in the desire for privacy and security, which is, as we have seen, constantly present to the native mind, but also to the fact that a well lighted house appears to the native to be uncongenial and uncomfortable.

In the case of the chawls in Bombay, although the large majority of the rooms are provided with windows, many of these, as before said, open upon dark gullies. Again, there are many rooms which are windowless. These, since the passages leading to them are often low and tortuous, are altogether dark. So much is this the case that it is often necessary, even in broad daylight, to have recourse to artificial light to find one's way about in certain portions of the houses.

I. (*e*) Existing conditions as regards character of the floor.

342. The floors of Indian houses, even those of upper storeys in many town houses, commonly consist of beaten earth covered over with cow-dung. The floors are renewed every week, as a semi-religious ceremony among the Hindus, by the application of a fresh layer of cow-dung, plastered on wet. When this has been recently done, the floor has a pleasant, smooth, and clean, appearance; it is cool and comfortable to the touch in summer and warm in cold weather, these being considerations of importance to the mass of the people, who go about their houses barefoot.

I. (*f*) Existing conditions as regards cleanliness.

343. Taken as a whole, the dwelling-rooms in India are surprisingly clean. This is due to the fact that the floors are periodically cleaned and renovated with cow-dung, that there is hardly any furniture in the rooms, and that the walls are generally not recessed in such a manner as to allow of the collection of dirt. Even where cattle are kept in the houses, the houses are not necessarily dirty, as the animals are not stalled in the dwelling rooms. What applies to the general cleanliness of the houses all over India, applies also to some extent to the chawls in Bombay. In these the majority of the dwelling-rooms—such at least as are in the occupation of single families—are kept neat and clean. On the other hand, the windowless rooms, where the very poor are crowded together, are, naturally, in a very filthy condition. Moreover, the passages and other portions which are used in common by the tenants, and for the cleanliness of which the landlord is responsible, are very much neglected, the walls and the woodwork being begrimed with smoke and grease, and the earth floors being in the wet weather trodden into mud.

I. (*g*) Existing conditions as regards removal of night soil.

344. Closely connected with the idea that plague is a filth disease is the idea that it may be associated with faulty drains and generally with night soil.

In Indian villages there are no special conservancy arrangements. The universal practice is for the villagers to resort to the fields in the outskirts of the inhabited site. Thus, there is no question of the accumulation of fæcal matter in village houses.

25,741-79.

In the towns and cities of India the conservancy arrangements naturally vary in different places. It will suffice here to consider the conservancy arrangements in Bombay. The City is divided into drained and undrained districts. In the case of the drained districts the sullage and fluid excreta only are carried off by means of drains. The night soil proper is collected into baskets, which are carried on the heads of sweepers to certain so-called depôts, where the material is shot into the main sewers. In the districts of the City into which the drainage system has not yet been introduced, the sullage and fluid excreta are carried off into cesspools, the night soil proper being, as in other parts of Bombay, carried to the depôts.

XI.(E.)(2.) *Existing Conditions in India in connexion with Sanitation outside Dwelling-houses.*

II. External conditions. Sewage pollution of the soil, high level of subsoil water, and narrow streets.

345. We may pass on now from the consideration of the insanitary conditions in the interior of dwelling-places to enquire what insanitary conditions external to dwelling-houses have been alleged to have an influence on the spread of plague. In doing this we find that the sewage pollution of the soil in Bombay—due to the presence of cesspits and open drains in the undrained districts, and to faulty connexions in the drained districts, of the town—has constantly been asserted to be the cause of the presence and persistence of plague in the City. Similarly the high level of the subsoil water in Bombay—due to the fact that the City is, in large part, built on land reclaimed from the sea—has been asserted to stand in relation to the continued presence of plague in the City. Lastly, an influence has, in the case of Bombay and other towns, been attributed also to the narrowness of the streets and the deficiency of open spaces in the native quarters.

XI.(E.)(3.) *Measures intended to combat Plague by effecting Sanitary Improvements.*

Measures taken to improve conditions—App. XXVI. in Vol. II. of these Proceedings.

346. Attempts to combat plague by measures for the introduction of sanitary improvements in the houses have been made ever since the middle of the century in Kumaun, where under the Mahamari rules the housing of the cattle in separate sheds and the removal of the manure heaps to a distance from the houses have been prescribed. In the same way, the idea that the disease can be combatted by measures of sanitary improvement has to a great extent directed the actions of the sanitary authorities in dealing with the plague in the City of Bombay and many other places in India affected and threatened by plague.

of overcrowding;

An endeavour has been made to relieve to some extent the overcrowding in the most infected quarters of Bombay by instituting health camps, and by inducing the people to establish themselves in these. It has, however, in view of the enormous population which has to be dealt with, been impossible sensibly to relieve the general overcrowding by this means.

of bad ventilation;

Para. 666 of this Report.

Similarly, in connexion with plague operations, efforts on a large scale have been made throughout India to remedy the defects in ventilation which have just been described. We shall presently see that in connexion with plague measures the drastic method was adopted of unroofing whole villages. In hundreds and hundreds of villages where this extreme measure was not carried out, holes were knocked through the roofs and through the walls of the houses for the purpose of improving the ventilation. In the case of Bombay and other cities, every "insanitary looking" house was partially untiled. In the case of crowded chawls in Bombay, the partitions referred to above as having been put up in the rooms were in many cases removed so as to allow of a certain circulation of air. Holes were cut in the walls above the doors. In some cases holes were made also in the ceilings so as to allow of the passage of air from floor to floor throughout the building. No permanent improvement, however, has been effected either in towns or in villages, for the general experience has been that the people soon close up the openings again, and everything reverts to the *status quo ante.*

of damp;

With a view to remedying the excessive damp in the dwellings in Bombay City, the water has, in many instances, been cut off from the houses, and the only supply procurable has been from stand pipes in the streets.

of dirt and uncleanliness;

Under the belief that plague is pre-eminently a filth disease and more likely to occur in dirty than in clean houses, great efforts were in many cases directed to cleaning up the houses, and especially to whitewashing them, with a view to warding off the advent of plague. The whitewash, however, was in certain cases applied only to the outside of the houses. In Bombay, where the authorities thought they were able to foretell the direction which plague would take, particular endeavours were made to clean up the houses along the line which it was assumed that plague would follow.

of defective conservancy arrangements;

Lastly, in accordance with the prevailing idea of plague as a filth disease, and a disease which is connected in some way with fæcal matter, the efforts of the sanitary authorities were, in the case of large cities, directed to the improvement of conservancy arrangements. Latrines and sewers were flushed down, and a spirit of greater activity was infused into the ordinary operations of conservancy. In Bombay thousands and thousands of gallons of carbolic acid were thrown down the drains, and the drain pipes were, in some cases, taken down from the houses and put through a process of steeping in hot water, which was in intention a process of disinfection.

of sewage pollution, high-water level, and narrow streets.

With regard to measures for improving the insanitary conditions associated with the sewage pollution of the soil, the high level of the subsoil water, and the existence of narrow streets in the native quarter, it may be noted that, in the case of Bombay, large schemes for subsoil draining, and for the broadening of the streets, and the rebuilding of certain of the native quarters, have for some time past engaged the attention of the Government in Bombay. Activity in this direction has not been confined to Bombay City.

XI.(E.)(4.) *Discussion of the probable Influence of the various Insanitary Conditions on Plague.*

Effect of overcrowding discussed.

347. Approaching the question of the effect of overcrowding in houses from the *à priori* standpoint, it would seem certain that in a crowded house there must not only be greater opportunities for the direct transference of an infectious disease

from the sick to the healthy, but there must also be greater opportunities for the indirect transference of such a disease by means of infected articles or the infected floor. When, however, we leave these *à priori* reasonings, and come face to face with the question as to whether as a matter of experience an association has actually been observed to exist between the crowding of houses and the prevalence of plague, we can, indeed, point to instances such as those already cited in a previous section, where a number of plague deaths have occurred in a single house. We may, if we please, adduce these as illustrations of the influence of overcrowding on the spread of the disease. But individual instances are, in such a case, inconclusive, inasmuch as many other contrary instances might be adduced in which plague did not spread in overcrowded chawls. The statistical method is obviously the only method by which a general proposition, such as that now in question, can be established. Such a statistical method has been employed in the case of Bombay.

Statistical investigation of effect of overcrowding in Bombay. Deductions drawn by Mr. Hankin from statistical data. 25,665-7.

Annales de l'Institut Pasteur, November 1898.

348. An endeavour was there made to compare the number of plague deaths in the more densely populated districts of the City with the number of plague deaths which occurred in the more sparsely populated districts. Figures subserving the comparison in question have been collected by Lieut.-Colonel Weir, I.M.S., Medical Officer of Health for Bombay. These figures, which are published in Lieut.-Colonel Weir's Annual Reports, and which were furnished to us by him, set forth, on the one hand, the number of plague deaths which occurred in each ward, and, on the other hand, the average number of persons per house, and per unit of superficial area, in each ward. Lieut.-Colonel Weir's figures, so far as they were at the time available, were considered by Mr. Hankin in a paper already referred to. Mr. Hankin has presented the results of Lieut.-Colonel Weir's figures in the form of a series of graphic curves. These curves show clearly that there is no inter-relation between the density of the population in the different wards of Bombay, as estimated on the basis of Lieut.-Colonel Weir's figures, and the severity of plague in those wards. More than that, Mr. Hankin's curves show that plague has, generally speaking, in the case of Bombay, been most severe in the wards where the density of the population—as judged on the one hand by the number of people dwelling in each house, and on the other hand by the number of inhabitants per unit of superficial area—has been least.

Criticism of criteria of density of population employed by Mr. Hankin.

Neither of the criteria employed can, as a matter of fact, be considered as an accurate criterion of the density of population. On the one hand, we cannot take the number of persons per house as an index of the overcrowding of the houses in the different wards, inasmuch as the average size of houses varies very considerably in the different wards, those in the suburban districts being only one or two-storeyed, and as a rule comparatively small, while those in the centre of the town are in many cases large and many-storeyed. Thus the number of people per house in the case of Bombay gives an inaccurate measure of the relative overcrowding of the different parts of the City. Objections of not less weight can be brought against taking as a measure of the overcrowding in the separate wards the figures which are arrived at by dividing the population of each ward into the superficial area contained within the ward boundaries. This last criterion is, in the case of many of the wards, an absolutely fallacious one, firstly, owing to the fact that the average height of houses varies a great deal in the different wards, and, secondly, owing to the fact that there are included in certain of the wards quite extensive areas of land not built over. Manifestly, in the wards where the taller houses are to be found, the overcrowding would *pro tanto* be less than in the wards where the houses are for the most part one-storeyed. On the other hand, in the wards which contain much ground not built over, the density of the population would really be greater than would appear in the figures.

Conclusion that statistics do not show existence of any relation between overcrowding and plague. 25,676-9.

349. In spite of these considerations, which show that the figures available for calculating the density of the population do not accurately measure the density of the population, we have no doubt that they do, as a matter of fact, provide a rough indication of the density per superficial unit of floor space of the population in the different quarters. For we were assured by Lieut.-Colonel Weir—and indeed it is not a question on which there can be any doubt—that the conditions as regards overcrowding in the suburbs are not in any way comparable to those in the heart of the town. It would thus appear that the absence of direct inter-relation between the conditions of overcrowding and the prevalence of plague which is exhibited so clearly in Mr. Hankin's curves must, paradoxical as that absence of inter-relation may appear, be accepted as a fact of actual observation. We have ourselves calculated out the later figures given to us by Lieut.-Colonel Weir, and we have arrived at the

same result as Mr. Hankin. The fact of this complete absence of inter-relation between density of population and the prevalence of plague is interesting, as showing how little *à priori* judgments are to be trusted in matters relating to the influence of sanitary surroundings upon the prevalence of plague.

Effect of absence of ventilation discussed.

350. *A priori* it would appear possible that an absence of ventilation may exert an effect upon the spread of plague by reducing the vitality of the inhabitants who live in a vitiated atmosphere. It is, in other words, conceivable (though we have no data for arriving at a decision on this question) that persons living in a vitiated atmosphere may be rendered more susceptible to contract the infection. If they are not directly rendered susceptible to the infection of plague, they may possibly be rendered susceptible to pulmonary diseases, which would increase their liability to contract certain forms of plague. Further, absence of ventilation and a vitiated atmosphere may possibly exert an influence upon the plague bacillus when it has escaped from the infected organism. Inasmuch as the absence of ventilation in an overcrowded house implies the existence of damp, that absence of ventilation may, on the one hand, postpone the destruction by desiccation of the plague bacillus, and, on the other hand, may interfere with the carrying away of the infective material, which would, in the case of a thoroughly ventilated room, be effected by currents of air as soon as the infective material had dried up and become pulverised. Further, in view of the facts elicited by Dr. Marsh, with regard to the effect of carbonic acid upon the growth of the plague bacillus, it is conceivable that an excess of carbonic acid in the atmosphere, such as would be met with in an ill-ventilated or overcrowded house, might be a factor favourable to the saprophytic growth of the plague bacillus. In view of these considerations, it would seem possible that the absence of ventilation may, to some extent, be favourable to the spread of plague. Para. 162 of this Report.

Even if definite data were available to establish the greater spread of plague in ill-ventilated than in well-ventilated houses, it would have to be borne in mind that a vitiated atmosphere is, as already indicated above, practically always associated with conditions of overcrowding, which, even in spite of the fact that the statistical evidence in the case of Bombay points in the contrary direction, may nevertheless exert an influence on the spread of plague. It would, therefore. be futile to ask from experience for actual proof or refutation of the conclusion that the absence of ventilation is favourable to the spread of plague. Proof, however, is adducible to show that freedom from plague is not always associated with the existence of good ventilation. To show that plague may occur in houses whose atmosphere is quite untainted, it will suffice to refer to the fact that plague cases broke out in well-ventilated and airy houses in Hardwar, Karachi, Ahmednagar, and elsewhere, and that an epidemic broke out in the lofty and, from every sanitary point of view, unimpeachable buildings of the Byculla Jail in Bombay. With regard to the last, it is to be remarked that while the epidemic was not a severe one, the incidence of plague was, relatively speaking, greater than in many of the most overcrowded chawls in the City. Lieut.-Colonel Weir, I.M.S., was so struck with this fact that in his Report he calls attention to it in the following terms :—"Here we have a population, all living under the same excellent sanitary conditions and under the same regulations, and in a space more beautifully clean than can be found in city life anywhere, suffering as the people in many of the most overcrowded parts of the City." 11,095. 24,228. 25,682.

Again, even though we may take it as established that plague does not show the same tendency to spread in evacuation camps as it does in unevacuated villages, it is manifest that we cannot determine how much of the advantage which accrues from moving out into camp is due to the breathing of an unvitiated atmosphere; how much is due to the spacing out of the people in camp, so that they are brought into less intimate contact than in their homes with infected persons; how much again to the more rapid desiccation of infective material in camp; and, lastly, how much to the removal of people from the sources of infection in their houses.

Whatever may be the importance which attaches in the case of camps to the factor of ventilation, we have little doubt that the importance of this factor is greatly exaggerated by those who urge that plague cannot occur in well-ventilated, airy, surroundings, and endeavour to trace back every outbreak of plague to a defect of ventilation.

Effect of damp discussed.

351. With regard to the closely related question of the influence of damp on the spread of plague, very little in the way of definite information is available. It is conceivable that damp may, either by conducing to pulmonary diseases, or in some

other way, reduce the resisting power of the human organism, and thus favour the spread of plague. While, however, this point is doubtful, there can be no doubt that a damp atmosphere in houses would, as we have already seen in discussing the effects of meteorological conditions on the spread of plague, supply one of the conditions which is favourable to a prolonged survival of the plague bacillus outside the animal organism. But, as we have indicated in the section just referred to, in damp surroundings influences might make themselves felt which, by allowing of the freer growth of saprophytic micro-organisms, would be hostile to the survival of the plague bacillus.

Para. 336 of this Report.

Effect of ill-lit or dark rooms discussed.

352. With regard to the effect of dark or ill-lit dwelling-rooms on man, there is no reason to suppose that such an absence of light as comes into consideration in the case of Indian houses is by itself injurious to health. On the contrary, it is quite natural that, as a relief from the glare of the bright sunshine, dark rooms should in India be congenial. Again, there is no evidence to show that the saprophytic growth of the plague bacillus (supposing always such saprophytic growth actually to take place in infected surroundings) would in any way be furthered by the absence of light. As will be seen, in discussing the effect of light in connexion with disinfection operations, we did not in our experiments obtain any evidence that diffused daylight can retard the growth of the plague bacillus. It is, indeed, conceivable that the period of survival of the bacillus after its escape from the body may possibly be prolonged when the bacillus is screened from the light, for the longest periods of survival which have been placed on record are periods observed in the case of plague bacilli which have been kept in the dark. There are, however, no comparative experiments which tell us what is the maximum period of survival of the plague bacillus when exposed to the influence of diffused light.

Para. 658 of this Report.

Effect of cow-dun and earth floors discussed.

353. From the point of view of the sanitarian, the cow-dung and earth floors, which are practically universal in India, are obviously very undesirable. Like a sponge, they soak up all discharges, and, quite apart from the fact that they are periodically renewed with moist cow-dung, they are naturally very retentive of moisture. Obviously also such floors, when they lie directly upon the soil, do not offer the same obstacle to the burrowing of rats as floors laid with boards or tiles or cement. The floors of native houses thus may quite well play an important part both in facilitating the introduction of infection by rats and in keeping the infection of plague alive in a house. Again it is quite certain, as we shall see in the section of our Report dealing with disinfection, that these floors render the destruction of the plague bacillus by chemical agencies much more difficult and uncertain than it would otherwise be. We have, however, practically no data which would enable us to arrive at a definite conclusion as to whether plague has actually been more rife in houses with cow-dung floors than in similar houses provided with cement or stone floors. One witness, Dr. Gibson, had, as he informed us, entered upon an investigation with a view to collecting definite information upon this question, but the information which he was able to bring forward at the time of his examination was incomplete and inconclusive.

Section III. (4) (*b*) of Chapter VI. of this Report.

17,289-290.

Effect of dirt discussed.

354. When we look around for a justification of the opinion that plague is a filth disease, we are confronted with the fact that the dirt which accumulates in houses is in all probability not a good culture medium for the plague bacillus. Taking the fact that the plague bacillus grows with extreme difficulty in the presence of most saprophytic micro-organisms, in conjunction with the fact that Dr. Marsh's observations have shown that there is an average of over 3,000,000 saprophytic bacteria in every gram weight of dirt scraped from the floor of native houses, we can hardly find justification for the belief that plague is a filth disease in the sense that the growth of its bacillus is favoured by the presence of dirt. If, therefore, dirt is contributory to the spread of plague, it can only be when, owing to its association with moisture, it plays a part in retarding the destruction of the plague bacillus by desiccation. Except in so far as dirt in a house may exert an effect in this direction, its presence would appear, from the point of view of the spread of plague, to be a matter of indifference, unless possibly as an indication of the absence of any efforts on the part of the inhabitants to purge their houses of infective material, supposing such to have been introduced. On the other hand, from the point of view of the sanitarian, a clean room manifestly may constitute as dangerous a nidus of infection as a dirty room, inasmuch as the specific micro-organisms of the disease may effect a lodgment or remain in the room in spite of any amount of sweeping and cleaning. These *à priori* conclusions appear to be fully borne out by the teaching of experience. The "cleaning-up

18,862.

operations" which were undertaken not only in Bombay, but also in nearly every other town which has been attacked by plague, have not, so far as we are aware, done anything to divert plague from the cleaned and whitewashed houses.

Effect of fæcal contamination of houses and soil discussed.

355. We pass now to the discussion of the question of the influence exerted on the spread of plague by the fæcal contamination of the houses and soil. This question, which has assumed so large a measure of importance in the eyes of lay sanitarians, may, it seems to us, be disposed of in a few words. Our sketch of the methods by which the night soil is removed in the rural districts generally and in Bombay City will have made it plain that, if the spread of plague were influenced to any important degree by fæcal contamination of the houses or the soil, it would have been much more severe in Bombay City than in the villages where the arrangements practically exclude the fæcal contamination of houses. The percentage, however, of the population attacked has been far greater in infected villages than in Bombay. Again, if contact with night soil was a frequent cause of plague, we should have expected to find an extremely high plague mortality among the sweepers in Bombay, who carry the night soil in open baskets on their heads; on the contrary, that mortality has, as we have already seen, been comparatively light. It has compared very favourably with the mortality from plague in many other classes of the community. It is very noteworthy that the conservancy arrangements, which exert so important an influence in other epidemic diseases, do not appear to exercise any very important influence upon the spread of plague.

Para. 344 of this Report.

Para. 306 of this Report.

Effect of sewage pollution and high level of subsoil water discussed.

356. No exact information has been furnished to us which either confirms or refutes the suggestion that the sewage pollution of the soil and the high level of the subsoil water are responsible for the persistence and severity of the plague in Bombay City; but it is clear that plague may occur as severely and persist as long as in Bombay in places such, for instance, as the towns in the Thana district, where the conditions, in respect of the inhabited sites, of sewage pollution, and of the height of the subsoil water, are much more favourable than those of Bombay, while the climatic conditions are generally similar.

Effect of wide streets and open spaces discussed.

357. In view of the fact that schemes involving the widening and re-construction of the streets have been set on foot directly with a view to checking the spread of plague, we may briefly glance at the question as to whether wide streets and open spaces as such, and apart from the character of the houses, exercise an influence upon the spread of plague in their neighbourhood. *A priori*, this could hardly be expected. None the less, with a view to ascertaining whether any lessons had been learnt in Bombay with regard to this question, we made inquiries from Lieut.-Colonel Weir, I.M.S., the Health Officer for Bombay. Lieut.-Colonel Weir told us that plague had been quite as severe in the newly-opened wide thoroughfares of the Byculla district, and in particular in Morland Road, and in the houses which adjoined large blocks of unoccupied land, as in the houses situated in narrow streets.

25,700-15.

Question as to whether a combination of sanitary defects influences plague.

358. It will, on a review of everything that has been said above, be manifest that we have not been able to discover any clear evidence to connect plague with any one of the various conditions grouped together under the head of sanitary defects. Failing such evidence, it behoves us to see whether the spread of plague can be brought into relation with any combination of the above-mentioned sanitary defects. Opportunity for bringing this question to a definite test would appear to be afforded by the circumstance that in Bombay City a census was taken of the most insanitary houses, with a view to the compulsory vacation of those which appeared unfit for human habitation. Mr. Hankin, in the paper already referred to, considered such of the figures of this census as were available at the time of writing. He has plotted out the statistical data thus placed at his disposal in a graphic form, figures representing the number of plague cases in different quarters of the town being placed alongside of figures representing the number of houses condemned as unfit for human habitation in each of these quarters. It is clearly seen, on consideration of Mr. Hankin's diagrams, that the severity of plague in the separate districts has not stood in any relation with the number of houses which were condemned as unfit for human habitation in those districts. It appears to us that these comparisons of Mr. Hankin's are, for several reasons, fallacious. In the first place, the number of houses given by him as having been condemned as unfit for human habitation amounts in all to the very small number of 1,903. Further, these 1,903 houses being for the most part quite small houses,—

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in many cases partaking of the nature of cabins or huts or annexes to larger houses,—the number of their inhabitants must have been quite insignificant, and the rate of mortality among these cannot seriously have influenced the mortality of the quarters where they lived. Moreover, there appears to be a serious doubt whether the number of houses condemned was actually as high as that given by Mr. Hankin, for 25,666. in figures furnished to us which purport to represent the number of houses condemned in a period longer than that specified by Mr. Hankin, we find that the total number of houses condemned is set down as 665. Many other objections suggest themselves to using the number of houses condemned in a district as a criterion of the sanitary conditions of that district as a whole. We may give a few examples. First. the conclusion that the average house in a district is insanitary does not follow from the fact that some houses in that district have been condemned as insanitary; as a matter of fact, as already stated, many of the buildings condemned in Bombay were mere annexes of large and more sanitary houses. Again we understand,—though Mr. Hankin appears to be under a different impression,—that the particular census of insanitary houses, on the results of which he based his arguments, was in different districts committed to different officers, and that the number of houses condemned as insanitary in a district varied to a large extent with the zeal and the standard of sanitary requirements which was set before himself by the individual census officer entrusted with the duty. Lastly—and this is the most serious objection, inasmuch as the figures for plague deaths relate in part to a period subsequent to the condemnation and vacation of houses unfit for human habitation—these figures for districts in which a large number of houses were condemned may be treated as figures applying to districts where sanitary conditions may, by the elimination of the worst houses, have been raised to a higher general average. For all the reasons stated above we must conclude that the figures adduced by Mr. Hankin do not supply either proof or disproof of an absence of inter-relation between defective sanitary conditions and the severity of plague.

Conclusion that no statistical or bacteriological evidence available showing that sanitary defects influence spread of plague.

359. On consideration of everything that has been said in connexion with the influence of sanitary surroundings, both within and without the house, on the spread of plague, it will be clear that we have been unable to find anything in the nature of statistical evidence or in the nature of inference from scientific observations to establish the proposition that any of the sanitary defects referred to, or any combination of them, exercises any marked favouring influence on the spread of plague.

History of recent epidemics affords no proof that sanitary defects aggravate plague.

360. We may judge of the question also by inquiring into the general history of recent plague epidemics. We may note, in the first place, that Calcutta and Mysore, cities whose sanitary conditions are as bad as, if not worse than, those of Bombay, have suffered much less severely from plague, and this in spite of the fact that the measures taken in these cities to check the spread of the disease have been much less strenuous. Oporto again furnishes another example of a town in which, in spite of the existence of all kinds of insanitary conditions, plague showed little tendency to spread. The sanitary condition of the infected quarter near the river wharfs may be judged of from the following passage taken from the report of Drs. Calmette and Salimbeni, who were sent by the Pasteur Institute in Paris as a Commission to investigate the plague in Oporto. "The Fonte Taurina and Customs quarters, where the epidemic began, are made up of blocks or islands of tumble down houses, divided by narrow lanes, in the form of tortuous staircases, unprovided with either sewers or gutters. Here and there, at irregular intervals, one meets with receptacles containing dirty rubbish of all sorts, which has accumulated for centuries. The sun does not penetrate into these lanes, and the air has a nauseating odour, and is mixed with acrid smoke. Nearly all these miserable dwellings consist of three or four rooms placed one on the top of the other, each occupied by entire families. Sometimes the ground floor provides asylum for animals—pigs, goats, and rabbits,—these being mixed up indiscriminately with the human inhabitants in an area of a few square metres. It is impossible to picture the squalor of these people. One thing only," say these observers, voicing the feeling of almost every one who for the first time observes the course of plague in the midst of insanitary surroundings, "can excite wonder—that plague did not make greater ravages here." Not only did plague not spread in any alarming manner in Oporto, but the disease appears to have quite died out in the surroundings which have been described, and this in spite of the fact that the sick were not compulsorily removed to hospital. Again, the same lesson seems to be taught by the history of plague in the City of Canton and in Hong Kong; the epidemic in Canton declining

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at the same time as the epidemic in Hong Kong, although in the one case no measures, and in the other case very strenuous measures, were taken for the improvement of general sanitation. We may note further, in the case of Poona and Bombay, that in spite of all the cleaning and opening up of houses and other sanitary improvements which accompanied the first and second epidemics, the third epidemic was much severer than either of the previous ones. The history of particular epidemics in recent times, therefore, does not appear to afford proof that insanitary conditions exercise any marked favouring influence on the spread of plague.

Opinions of plague officers regarding influence of sanitary conditions on spread of plague.

361. The only kind of evidence which still remains for us to examine is found in the opinions of plague officers who have had actual practical experience of plague as seen in the houses of the native population. We have, therefore, carefully gone through the evidence, and after so far as possible excluding such opinions as seem to us to have been founded upon theoretical considerations rather than on practical experience, we subjoin the opinions which seem to us to be most deserving of consideration in connexion with this question.

7836. Surgeon-General Harvey, Director-General of the Indian Medical Department, who had opportunities of seeing plague in many infected centres, told us that "as seed cannot grow without proper soil, so this plague seed cannot flourish unless it finds an environment suited to it, and that environment is made by all these insanitary conditions. It is a disease of filth, a disease of dirt, and a disease of poverty. The whole history of plague, so far as we know it, shows that to a great extent."

21,323. Lieut.-Colonel Fawcett, R.A.M.C., who had great practical experience of plague in Poona, said, "It is unfortunately an axiom that plague in its epidemic form is only to be found where dirt, darkness, and overcrowding prevail; in a word, in those places where sanitation is unknown, impossible, or neglected . . . . the bacillus which causes it, though capable of multiplication with extraordinary rapidity in a suitable nidus, has neither the power of resistance, locomotion, or spore formation, and dies at once in the light of day."

23,180-6. Major Anderson, I.M.S., apparently attributed the severity of plague in the Dharwar district to the filthy condition of the houses and their defective lighting and ventilation, and the custom of keeping cattle in them.

10,377. Captain James, I.M.S., who was in medical charge of the plague operations in the Punjab, expressed the opinion that "light and air seem to be inimical to the spread of plague, while dark and badly ventilated places are conducive to it."

11,228. Mr. Giles, the Commissioner in Sind, who had great experience in Karachi, though
he had noticed plague occurring in houses of a superior character, said that "there
was not the faintest doubt that the ill-ventilated houses where the people were crowded
11,281. got the plague far the worst. It was quite apparent." He told us also that want of
ventilation, dirt, and overcrowding, were in the order given responsible for the extension
and virulence of the disease.

11,851. Mr. Kaka, Health Officer of Karachi, thought that "where sanitary conditions were good, plague does not assume a very virulent form."

Dr. Clemow, who based his opinion on his experience of one district in Calcutta,
and on his observation of the dirty condition of the patients whom he had seen in the
7179-80. Parel Hospital at Bombay, thought that there was "evidence to show that insanitary
conditions favour the spread of plague."

16,971-86. Mr. Stewart, I.C.S., who had experience both in Bombay and in Nasik, while unable to say that plague, generally speaking, occurred in the worst houses in a district, remarked that the houses in which cases occurred were defective in some way, either in respect of light, or of ventilation, or of overcrowding.

II. 361. Surgeon-General Planck thought that the prevalence of plague in Kumaun was to a large extent due to the insanitary conditions of the houses and in particular to the custom of keeping cattle in the lower storeys, and of using the sleeping rooms as granaries, and he remarked that the two periods in which energetic steps were taken, under the Mahamari rules, to remedy these defects, were periods which were unaccompanied by any violent outbreaks.

Major Reade, R.A.M.C., who was in charge of the plague operations in Poona, and
who had observed plague, not only in India, but also in Hong Kong, when asked
whether better hygienic conditions were operative in diminishing the amount of plague
when people were removed into camp, expressed himself in the following guarded
21,718-9. way:—"It is a presumption that, if you take people from ill-ventilated houses and

place them in good airy houses, the hygienic conditions are better, and one can say that, under better hygienic conditions, the general health will improve." But this witness was more definite as to the influence of the cow-dung and earth floors in aiding the propagation of plague. He thought they certainly contributed to the spread of the disease. 21,725.

The Bombay Scientific Committee, consisting of Major Lyons, I.M.S., Major Manser, I.M.S., Captain Childe, I.M.S., Dr. Surveyor, Mr. Haffkine, and Mr. Hankin, appointed to make investigation into the nature of plague and the means of its spread, in its Report, states: "All observers up to the present time have connected the occurrence and diffusion of the disease with want and filth, and there seems to be no doubt that these factors do favour it, in so far as they lower the general health and diminish natural immunity. But it will be seen that filth *per se* has but little influence, from the fact that there occurred in the House of Correction, Byculla, where cleanliness is brought as nearly to perfection as is attainable, an outbreak which exceeded in severity that in any of the filthy chawls and tenements around." I. 378.

Lieut.-Colonel Weir, I.M.S., Health Officer of Bombay City, said, "I think the view of associating this disease with dirt, in the sense of refuse, is utterly wrong. As far as I understand, when once the microbe gets into dirt, it becomes harmless. My reason for thinking that is that the classes here who handle dirt and walk in dirt have suffered less than classes who avoid dirt most. I do not see that there can be any other explanation—that microbes when they get into dirt are destroyed by others." 1003-4.

Dr. Nield Cook, who, as Health Officer of Calcutta, had exceptional opportunities for observing the distribution of plague in that City, said, "Some of the cases were in very good houses, in decent sanitary streets; certainly a number of cases were in a poorer class of houses . . . . I think it is very much a matter of where the infection gets carried, and I have no doubt it has a greater chance of being carried in poorer localities, where people mix about in closer contact and are generally crowded together; but I do not think there is sufficient evidence that the contagium morbi prefers foul places to healthy places." 6659-60.

XI.(E.)(5.) *Conclusions regarding the Influence of Insanitary Conditions on Plague.*

Conclusion regarding influence of insanitary conditions on plague.

362. The opinions of those witnesses who hold that plague occurs most frequently in dark, ill-ventilated, and overcrowded, houses, and of those who hold with Dr. Nield Cook, that the disease breaks out wherever the infection may be carried, whether the sanitary conditions be good or bad, are not, it seems to us, in necessary contradiction. They can be harmonized if we assume as we must, even in face of the fact that the plague was severest in the less crowded districts of Bombay, that the factor which more than any other is likely to determine the introduction and spread of plague in a house is the crowding together of a number of inhabitants in that house. While the more frequent occurrence of plague in the crowded, dark, ill-ventilated, houses which serve as dwelling-places for the very poor would be easily explained in accordance with this view, we are very far from suggesting that in certain of these houses there may not be some special insanitary condition which may be contributory to the spread or persistence of plague.

Possibility of effecting improvements in insanitary conditions in India.

363. In the absence of anything in the form of definite knowledge on the question as to what may be the special nature of the existing defect which comes into consideration here, it would seem to us that the great practical question which presents itself for solution is the question of the prevention of overcrowding. In approaching this subject, we must recognise that much of the overcrowding which prevails in India generally is directly attributable to poverty. The overcrowding which is directly attributable to this cause would appear to be irremediable, except in so far as the economist may be able to devise means for increasing the general wealth. But with regard to the overcrowding which actually exists in the chawls and lodging-houses of Bombay, it appears to us that much of this is due, not so much to poverty, as to the fact that the influx of persons seeking work in the mills has, in the absence of any legal restraint on the number of persons who may be accommodated in lodging-houses, afforded unscrupulous landlords an opportunity of overcrowding their houses to the utmost. It would seem possible by a properly devised Lodging House Act to relieve some of this overcrowding and such insanitary conditions as are associated with it. It might be possible, as has been found possible for instance in the case of Hardwar and Simla, to regulate the number of people who are admitted into each room on the principle of allotting to each a certain minimum of cubic space. It would also seem

possible to enact that there should be a certain provision for ventilation, and with it for the admission of light into the houses. The enforcement, however, of general structural improvements in town or country in the case of existing private houses would appear to be out of the question. It would be impraticable to enter on a scheme for rebuilding all India and for bringing it into conformity with modern sanitary ideas, by enacting that every room should be provided with windows, and that cemented or paved floors should be substituted for earth and cow-dung floors. Even if it were possible to carry out such a scheme of reform as this—and it has already been seen that reforms involving large rebuilding schemes have in particular places been carried through in connexion with measures taken against plague—it would not be possible without a legion of inspectors to ensure that the people did carry out the improvements required and that there was no subsequent backsliding. How necessary it would be to attend to this last point will appear from the fact that, where measures for improving the ventilation of the houses were carried through in connexion with plague measures, the people for the most part closed up the ventilation openings at the earliest opportunity.

Directions in which improvement in insanitary conditions might be effected.

Para. 750 of this Report.

364. While thus we are of opinion that measures of sanitary reform in the existing houses cannot be introduced, or cannot, at any rate, be introduced on a large scale, we think that certain important steps in the direction of sanitary reform could be taken in the case of the large towns. Not only could, as we have above suggested, a system of licensing and regulating lodging-houses be introduced, but, as we have elsewhere suggested, it would be possible to give the Medical Officer of Health for each large town a right of vetoing the erection of grossly insanitary buildings within the precincts of his Municipality. Along with this power of vetoing the erection of new insanitary houses ought, we think, to go the power of vetoing the rebuilding in an insanitary manner of the houses which now exist. By taking these steps we think that a gradual revolution in the sanitary conditions in Indian towns might be brought about without undue interference with existing rights or customs.

Chapter VII. of this Report.

It would be travelling beyond our province to discuss the question of possible improvements of sanitary conditions by the institution of subsoil drainage or by the adoption of better conservancy arrangements. Recommendations in connexion with these questions would, it seems to us, fall more suitably within the province of the Sanitary Department, which, as will be seen elsewhere, we think ought to be immediately established in India.

The President disagrees with many of above statements and conclusions regarding influence of insanitary conditions on plague.

365. As the President is unable to agree with many of the statements and opinions contained in this section, (XI. (E.)), he has separately expressed his personal views in a Memorandum printed as Appendix No. III. to this Report.

XI.(F.) *Question of the Existence of an Endemic Focus of Plague in the Foot-hills of the Himalayas.*

History of the earlier investigations into the occurrence and nature of Mahamari in the Hills. Appendix XXV.

Appendix XXV., para. 95

Appendix XXV., paras. 96, 97.

366. An interesting side light on the problems connected with plague may be obtained by a consideration of the question of the existence within the confines of British India of an endemic plague focus in the Kumaun and Garhwal districts, which are situated on the lower spurs of the Himalayas. The occurrence in this region of a fatal form of disease of a type unfamiliar elsewhere in India was, as we learn from Surgeon-General Planck's valuable Report on the question (printed in Volume II. of our Proceedings) brought to the knowledge of the Government as long ago as 1836. According to the reports which reached the Commissioner of Kumaun of that day, the disease in question originated in 1823 at Kidarnath—an important place of pilgrimage—in the person of a priest of the shrine. In 1834 to 1835, when the disease was first made the subject of a report, it was (we quote from Dr. Planck) noted upon by the Revenue Officers as follows:—"The appearance of the disease in a village had been observed to be preceded by mortality amongst the rats of the village. The onset of the disease in man is described as sudden, attended with fever, great thirst, and an eruption of buboes or swellings under the arms and behind the knees, with a desire to eat bitter things. After the appearance of the swellings choleraic symptoms appeared, and the disease generally terminated fatally in the space of two, three, or four, days, those who recovered being very much reduced for a long period." 633 deaths occurred in Garhwal from this disease in the epidemic of 1834 to 1835. In 1849 the statement that the disease was probably identical with Asiatic plague appears in a Report by Mr. Strachey, the Assistant Commissioner, in which attention is called to the ravages of the disease and to the deplorable condition of the people who had fled out of their houses to escape contagion. In consequence of these

presentations, Dr. Renny was deputed to make inquiry in to the disease. Dr. Renny ho did not succeed in seeing more than a few cases of the malady, formed the pinion that Mahamari, *i.e.*, "the great disease"—the disease had by this time become fficially denoted by this name, although it is locally known only as Gola Rog or hutkia Rog, both meaning "the bubo disease"—was not to be identified with Asiatic plague. He regarded it as "a malignant form of typhus, accompanied by external landular tumours, a very fatal disease, generally terminating in death within three r four days after attack." The recorded mortality from the outbreak of 1849 to 1850 was 103 deaths in nine villages. The measures recommended by Dr. Renny were the disinfection of the houses by fire, the lime-washing of all houses (inside and outside), the immediate removal of the bodies of those who had died of the disease, and the removal of the manure heaps from the neighbourhood of the dwellings. Further inquiries into the nature of the disease were made by Dr. Pearson and Dr. Francis conjointly, in the year 1852–3. These gentlemen, on the basis of "chemical study" and a certain number of post mortem examinations, arrived at the conclusion that the disease was plague. They recommended as an urgent measure the removal of the cattle from the lower storeys of the houses into separate sheds. Again, in 1877, the epidemiology of the disease and its symptoms were very fully and ably studied by Surgeon-General Planck, from whose Report most of the above statements have been culled. Colonel Richardson, I.M.S., Colonel Hutcheson, I.M.S., and Lieut.-Colonel Thompson, I.M.S., who, each in his turn, succeeded to the Sanitary Commissionership of the North-West Provinces, previously held by Surgeon-General Planck, made further investigations into the outbreaks of plague which have occurred periodically in Kumaun and Garhwal. As the result of these investigations, a sufficient body of clinical and epidemiological facts is at our disposal to justify the conclusion that the disease, which has long been known to occur in the Hill country, is, in reality, plague.

Appendix XXV., para. 98.

App. XXV. para. 103.

App. XXV. para. 106.

App. XXV.(1), Section V.

367. The more important circumstances which place the identity of the Hill form of the disease with genuine plague beyond doubt, are, first, those relating to the period of incubation. As the result of observations made in the case of persons who prematurely returned to revisit or reinhabit their evacuated houses, and in the case of persons who contracted the disease in their villages after exposure to infection newly imported from outside, it was determined that the incubation period of mahamari may be as short as 24 hours, and that it may, in some cases, extend to five days. The following cases are of interest in this connexion. A woman who lived in the healthy village of Kheti slept one night in the infected village of Kirsal and was attacked by plague next morning while walking home. She managed to reach her home, and next day a child living there was attacked. In Balt "all remained well" among the population who were camping outside their village on account of an outbreak of mahamari "until, a great fall of snow occurring on the 14th of January, the people returned to their homes, and during the succeeding five days four more deaths occurred in the houses of the terrace previously infected." On the 15th January, rice which had been imported from an infected village was husked in the village of Nainola: on the 18th, 19th, and 21st January cases of plague occurred in the house in which the rice was husked. These facts are, as will be seen on reference to the section of our Report where we deal with the incubation period of plague, in close agreement with those that have come to light in connexion with the disease as now prevalent in India.

Facts elicited by investigations referred to above place it beyond doubt that mahamari is identical with plague.

(1) Incubation period.

II. 362 (3).

II. 338 (111).

II. 342(130).

Section V. of this Chapter.

The sudden onset of the symptoms; the development of buboes either early or, in the presumably septicæmic cases, in the latter stages of the disease; the occasional occurrence of carbuncles; the extreme fatality of the disease; the frequent cerebral complications, evincing themselves either in the form of passive hallucinations or in an uncontrollable tendency to wander about, which often caused the patients to leave their houses and to throw themselves down steep places: these all point to the identity of mahamari, as seen in the Hills, with true plague.

(2.) Clinical symptoms.

II. 359 (242),

II. 369(6*c*).

Similarly, the epidemiological data point in the same direction. The fact that a mortality among rats* and mice in some cases precedes the outbreak of the disease among men; the fact that the disease is very rarely contracted by direct contact with the sick, while it spreads rapidly among the people who remain in or revisit their infected houses; the fact that the houses and goods retain the infection for long periods; and, in association with this, the fact that a long interval may occur between the importation of the infection and the subsequent spread of plague; and, perhaps,

(3.) Epidemiological data.

II. 361 (254 and 259).

II. 362 (4).

8832, 26,576,

II. 360 (247–9),

II. 362 (261),

II. 369 (6*c*).

II. 361 (254).

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* It is noteworthy that the rat which occurs in the Himalayas, and which is spoken of as being infected by plague, is described by Surgeon-General Planck as being, not the strong "black (*sic*) Norway rat which lives in the sewers of Europe, but a more delicate grey species."

8827, 8995, II. 363 (6).

II. 342 (130).

II. 340 (120).

II. 352-3 (199).

the fact that the disease shows a tendency to recur, as plague in Bombay and other places has done, in the colder months of the year, and to disappear in the summer: all these again point to the identity of mahamari with plague. In connexion with the occasional occurrence of an interval between the importation of infection and the occurrence of the disease, we may note that in the case of Nainoli, just referred to above, an interval of over six weeks elapsed between the date of the importation of the rice from the infected village and the outbreak of the disease. The following cases also bear on the question. "In the month of November a boy of 15 went into Balt village to fetch wheat for seed; he remained one night in Balt, sleeping in a house in which a woman was ill of Gola disease. . . . . Fifteen days after he came home again, his little sister was taken ill with continued fever and died after three days' illness." In the village of Baret, two suspicious deaths occurred in the month of November; on the 22nd April, a definite case of bubonic plague occurred in a second house in the village; in the first half of May two further cases occurred in the house adjoining that in which the deaths had occurred in November; and, lastly, at the end of May, a second case occurred in the house which had been infected in April. In none of the intervals which we have cited was any mortality among rats noticed. In connexion with the influence of the seasons on the occurrence of mahamari, we have ascertained from Surgeon-General Planck's Report, that of the 40 village outbreaks which he investigated, 4 commenced in October; 7 in November; 7 in December; 5 in January; 4 in February; 4 in March; 6 in April; 2 in May; none in June and July; 1 in August; and none in September. We may, however, note that the rule which seems to be deducible from these cases does not appear to be absolute, for in the case of six village outbreaks, for which details were collected by Lieutenant Walton, I.M.S., and Lieutenant Douglas, I.M.S., four appeared in the months of July, August, and September, and two only in the winter months.

II. 366-8.

Points in which plague, as seen in the Hills, appears to differ from plague as seen elsewhere in India.

368. A few minor points of difference between plague as seen in the Hills, and plague as it has appeared in the plains, would appear to be deserving of notice. The first of these is the fact that in plague, as seen in the Hills, the non-bubonic form of the disease appears to be much more frequent than the bubonic form. Out of 77 cases chosen from Dr. Planck's Report, from among those in connexion with which the necessary indications are supplied, we find that 56 were non-bubonic and 21 bubonic. The frequent mention of diarrhœa also deserves attention, as another circumstance indicating that plague assumes a more virulent form in the Hills. Indeed, the extreme fatality of the disease in the Hills is almost unparalleled in the plains. Out of 291 cases reported by Surgeon-General Planck, 277 ended fatally and only 14 recovered, giving a case mortality of over 95 per cent. Lastly, it is remarkable that no symptoms are reported from the Hills from which the occurrence of the pneumonic form of plague could be inferred. Lieut.-Colonel Thomson, I.M.S., speaks of pneumonia as being unknown in connexion with plague in the Hills.

8833, 8955.

Points unresolved by the inquiries of earlier investigators.

369. Several very important questions are unresolved by the information collected by Surgeon-General Planck and his fellow observers with regard to plague as it occurs in the Hills. Firstly, inasmuch as the information in question was collected at a date anterior to the discovery of the plague bacillus, it necessarily leaves unresolved the question of the bacteriological identity of mahamari and plague. Secondly, it leaves unresolved the question as to whether plague is really endemic in Garhwal and Kumaun, or whether it is periodically imported into these districts from beyond the borders of the district. Thirdly, it leaves unresolved the question as to how the infection of plague, supposing the disease to be endemic in the country, is kept alive in the intervals between successive outbreaks. Fourthly, it leaves unresolved the problem of the nature of "sanjar," an epidemic disease unassociated with buboes, which, when it appears in these districts, is not always easily discriminated from "gola rog"—true mahamari.

Preliminary steps taken with a view to the elucidation of the problems in question.

370. With a view to filling in, so far as possible, these lacunæ in our knowledge of plague as it occurs in the Kumaun Hills, we, shortly after our arrival in India, approached the Government with a request that the services of Captain Leonard Rogers, I.M.S. (who was then in charge of the Bacteriological Laboratory at Muktesar, on the outskirts of this region), might be made available for the bacteriological study of any cases of epidemic disease which might be reported in the district.

Captain Rogers' investigation of an epidemic designated as an epidemic of "sanjar."

An opportunity for investigating the nature of an epidemic notified as sanjar soon presented itself. It may be remarked that the malady locally designated by this name is regarded by Lieut.-Colonel Thomson, I.M.S., as possibly standing in some connexion with plague, this opinion being supported by the observation that, in an instance which came under his notice, outbreaks respectively designated as outbreaks of gola rog and of sanjar were occurring at one and the same time in adjoining villages. Captain Rogers, however, availing himself of the opportunity which offered itself for a particular study of the disease, had no difficulty in determining, from a consideration of the clinical symptoms, that the particular epidemic of sanjar in question was an epidemic of typical recurrent fever. In the case of one patient, the correctness of the diagnosis was confirmed by the fact that the spirillum of Obermeyer was detected in the blood.

8825-6.
8894-5.

Further steps taken towards the elucidation of the problems associated with mahamari.

371. With a view to elucidating the bacteriology of mahamari, and with a view also to obtaining more light on the general epidemiological problems connected with the disease than could be obtained by isolated inquiries into such cases of epidemic disease as might, from time to time, be officially reported, we, before our departure from India, suggested to the Government that important light might be thrown on the problem of the endemicity of plague in Kumaun and Garhwal by a more detailed inquiry into the nature and distribution of the epidemic diseases prevailing in these districts, and by special inquiry into the question as to whether the appearance of plague in these regions was or was not associated with a periodical importation of the disease from Tibet. We represented that Captain Walton and Lieutenant Douglas, both of the Indian Medical Service, who had been specially attached to us for the purpose of assisting in our work, would be specially qualified to undertake the investigation.

Results of Captain Walton and Lieutenant Douglas' inquiry. Plague truly endemic in the Hill; not periodically imported from Tibet.
App. XXV.(I) in Vol. II. of these Proceedings.

372. Captain Walton and Lieutenant Douglas performed the duties which were assigned to them in a very zealous manner. In view, however, of the fact that no cases of mahamari, or of any other infective disease, except measles, were to be found in the tract of country through which they passed, they were not in a position to make any bacteriological observations upon mahamari. On the other hand, like all recent observers, they were able, by personal inquiries, to convince themselves that the disease which breaks out periodically in Kumaun and Garhwal must be recognised as genuine plague. With a view to determining whether there was any possibility of the periodical outbreaks of plague in Kumaun being due to a periodical importation of the infection from the trans-Himalayan country, Captain Walton and Lieutenant Douglas proceeded to the foot of the passes which lead over into Tibet. They had there an opportunity of meeting certain Tibetan envoys who, according to custom, arrive at this period of the year to satisfy themselves, before the opening of the trade routes, of the absence of epidemic disease in British territory. These envoys, who appeared to be well informed with respect to the occurrence of plague in Kumaun and Garhwal, asserted that no disease of this kind was known in Tibet. Further evidence pointing clearly to the non-importation of the disease into British territory from Tibet was afforded by a study of the distribution of plague in Kumaun and Garhwal, which revealed that plague has in no case occurred in the villages which are close up to the Tibetan border. There can thus be no doubt as to the existence of a genuine endemic focus of plague in the foot-hills of the Himalayas within British territory.

II. 369(*d*).

Possible explanations of the endemicity.

373. The question immediately presents itself for solution as to how the infection of plague is kept alive in the country in the intervals which occur between one outbreak and another.

Theory that it may be due to distribution of the infection from sporadic cases considered.

It seemed possible that the outbreaks might be accounted for by the continual occurrence of sporadic cases, and by the distribution from village to village of the infection derived from these. With a view to obtaining light upon this question, Captain Walton and Lieutenant Douglas, on their failure to find any indication of the existence of sporadic cases of plague in the tract of country traversed by them, collected data with regard to the length of the periods of freedom from plague which intervene in the regions in question between successive outbreaks. A scrutiny of the plague records in the office of the Commissioner of Kumaun revealed that, although serious epidemics have occurred only at very prolonged intervals, it is exceptional for a year to pass in which mahamari is not reported from some one or other of the widely scattered villages in the districts of Kumaun and Garhwal. This fact, taken by itself, would manifestly be favourable to the view that the endemicity of the disease in the regions in question may be imputable to the distribution of the infection from a succession of sporadic cases. But this view, even if it is not rendered untenable by the absence of sporadic cases from the region traversed by Captain Walton and Lieutenant Douglas, must be definitely abandoned when the geographical distribution of the outbreaks is considered in the light of the difficulties of travel, the great distances between the villages which have been

II. 369-70(*e*).

successively affected, and the absence of intercourse between these. Some factor, other than the distribution of the infection from sporadic cases, must, therefore, be invoked to account for the endemicity of the disease.

Theory that intervals between epidemics may be bridged over by cases of pestis minor.

II. 369 (6c).

374. Another suggestion, which has been mooted in connexion with the explanation of the endemicity of plague in other places, is that the intervals between successive outbreaks may possibly be bridged over by a succession of cases of pestis minor. Although it is difficult, in view of the almost certainly non-infective character of ordinary cases of pestis minor, to suppose that the infection is kept alive by this agency, Captain Walton and Lieutenant Douglas made a careful search for cases of mild bubonic disease. The results of their search were entirely negative.

Theory that endemicity may be due to the infective agent surviving for prolonged periods in a dormant condition.

II. 354 (209), II. 360 (252). 8827, II. 364 (18), II. 366 (III.). 26,578, II. 361 (259), II. 363 (9).

26,575, II. 360 (250).

II. 338 (104–5). II. 361 (256).

II. 377(2).

375. Lastly—and this theory would appear best to explain the facts—it is conceivable that the endemicity of the disease may be due to the infective material lying dormant for prolonged periods in the soil or in the houses. Survival of the infective agent under such conditions would probably be favoured by the climatic conditions of Kumaun and Garhwal, and possibly also by the presence of damp in the dwellings arising from the stalling of cattle in the lower storeys and the storage of damp grain in the sleeping rooms. Again, the fact that certain villages have repeatedly been attacked by plague while many other villages have escaped; the fact that in the cases of villages where the disease has reappeared after a term of years, a mortality among rats has often preceded mortality among men; the fact that old and tumble-down houses (these being sometimes houses where there was a history of previous infection) have been attacked in such villages more frequently than new houses; and, lastly, the fact that the outbreaks have often commenced with women or children who are unlikely to have come into contact with outside sources of infection: all these appear to suggest that we may here be dealing with true recrudescences, *i.e.*, with outbreaks which originate in infective material which has long lain dormant. An indication, which perhaps points in the same direction as the facts just adverted to, is to be found in the statement of Surgeon-General Planck, that the periods when the Mahamari rules were strictly enforced (these last being measures directed to the improvement of the sanitary conditions of the houses by the removal of the cattle into outhouses and sheds) were periods of comparative immunity from plague; whereas the periods when these regulations were (owing to pressure of circumstances) allowed to fall into desuetude were periods of considerable mortality. While sanitary improvements of the kind in question could hardly render the people less susceptible to imported infection, they might manifestly exert an influence on the length of time to which the infective germ might survive in the houses.

The President considers that it should not be overlooked that the Mahamari rules above referred to, also require that every room in each house shall "have a window, two feet by two feet opening, on the outer wall of the house, in the wall opposite to the doorway for purposes of ventilation."

Facts relating to Kumaun appear to suggest possibility of true recrudescences in Plains.

376. Before bringing to a conclusion our remarks on this question, we may note that although, in India generally, because of the constant inter-communication between plague-infected and uninfected places, it has been impossible to establish that an outbreak of plague has ever occurred apart from an importation of the infection, there are many facts in the distribution of plague in the last four years for which the assumption that plague may recrudesce after lying dormant for prolonged periods would supply the simplest explanation. Such a recrudescence would fully explain the history of particular infected places in which periods of freedom from plague have alternated with periods when the disease is epidemic, even when the infected area—as, for instance, the area infected in the Punjab—is isolated and is confined within limits which do not to any great extent vary from year to year; and such a recrudescence would furnish us, in the case of India as a whole, with the cause of the seasonal periodicity of plague, which is marked by the sharp transitions in which periods when there is apparently a general dying out of infection are succeeded by a quick and general reappearance of the disease all over India.

XI.(G.) *Question as to whether the Infective Material of Plague must undergo a Preliminary Process of Adaptation or "Acclimatisation" before it can spread in any Locality.*

Theory that plague, before it can spread, has to be acclimatised to particular

377. We have already, in connexion with our discussion of the means by which plague has been carried from place to place in India, called attention to, and endeavoured to account for the slow rate at which the disease has (in spite of the railway communication which exists) spread outwards from infected centres. We saw that this slow rate

environment into which it is introduced. Section VII. (5) of this Chapter.

of spread was in large part the result of the comparatively slight infectivity of ordinary cases of plague, and that it was no doubt also the result of the steps which were taken to prevent the importation of plague cases into uninfected places and to discover and deal with them when introduced. The possibility that an acclimatisation of the plague bacillus to the particular environment into which it was in each case introduced might possibly be an essential preliminary to the spread of plague was incidentally adverted to as another factor which might conceivably have been contributory, along with the other factors before mentioned, to the slow rate of progress which has characterised the spread of plague through India. This question was, as will be remembered, reserved for subsequent discussion. We take it up at this point, with the remark that the problem could not profitably be adjudicated upon before the facts and considerations which have been set forth in the sections immediately preceding this had been duly weighed.

Sir Andrew Wingate's summary of facts which are capable of explanation by theory of acclimatisation, 26,537.

378. Passing now to the observations which the theory of acclimatisation has been invoked to explain, these are succinctly stated by Sir Andrew Wingate. This witness observed, "The point is that the spread of infection appears to me to be the same in the country as you find it to be in a town, that is, very localised at first, and spreading from a given centre. It is precisely the same if you extend your glance over the whole of India. The Bombay Presidency is the infected area, while the rest of India remains practically free. It is very striking. In every map you will see huge areas —highly populated areas—without a single case, or perhaps one or two only over a whole district. That seems to me to indicate that the outflow from an infected area is probably more dangerous close to the centre of infection than at any distance from it—that as the outflow gets further away from the centre, so the danger seems to lessen. Take the case of a man, starting from an infected house: if he goes 10 miles in two hours, he appears to be more dangerous than if he has gone 20 miles in four hours. Or it may be that the local spread of infection is due to entry into an infected area. It may be a market town which is infected, and where you have a market town the people from all the villages round go into the infected area: and, therefore, you get this localised infection. Into Ahmedabad or Broach the exodus from Bombay, I presume, has been as constant and as great in the past three years, but it is only this year that North Gujarat has been attacked. Take the town of Broach. You will find that it was not until Ankleshwar village, within 10 or 12 miles of Broach, was attacked that Broach was infected. That seems to me to point to the fact that the danger to Broach was not the incoming of people from infected areas at a distance, but either the outgoing of the people from Broach to an infected place within their easy reach, or the entry of people from a neighbouring infected village into Broach. You may say that the people of Broach went and came also to and from Bombay. That is so, but there you introduce two fresh elements—the one of distance and exposure to sun and air when going back to Broach, and the other of the medical inspection and the disinfecting arrangements, whether they involve detention or merely inspection. The people who go from Broach to Bombay by rail, and go back, come under those restrictions; and, therefore, are to a certain extent not so liable to introduce infection as when the infected area approaches close to a town. And there is the further danger that it is by the people of the town visiting that infected area that plague is also carried. All I wish to point out is, that as the Commission will examine our maps they will almost invariably find that the infected places are grouped; that when they hear of a district with 30,000 deaths in it, and expect to find the whole district a mass of plague, it is nothing of the sort. The plague is absolutely localised in certain parts of the district. It is just the same when going into a plague-infected town; you will be taken to one or two infected streets, and it is there where you have the chief mortality."

Acclimatisation theory put forward by Major Anderson, I.M.S. 23,318–29.

379. The view that this slow rate of progression is attributable to the time required for a preliminary process of acclimatisation to the local conditions was advanced by Major Anderson I.M.S., who had exceptional opportunities for observing the course of plague in the Bombay Presidency. He expressed the opinion that in the first instance, on its arrival in India, the disease was a coast disease which required some time to assimilate itself in such a manner as to secure a hold upon an inland place, whether town or village. "We learn," he said, "that many cases escaped from Bombay at 23,319. the beginning of the epidemic, and even after railway inspection was put on, still a large number got through. For example, in Nasik, before indigenous plague occurred, we had 35 imported cases. Those 35 imported cases did, I think, no harm." He also observed, "One other point which struck me concerning the outbreak in the 23,323.

Thana district was that no indigenous case occurred in any town or village more than five miles from tidal water. The disease, when it first appeared in Bombay, was undoubtedly a coast disease, and required a high subsoil water for its development; a town with a good water supply and no drainage suffering more than an equally dirty town with a deficient water supply." It was his opinion that since the disease had spread about in the interior, it more easily secures a hold upon new places, provided 23,328. those places be situated within a certain tract of country. He added, "Places in the Deccan are much more easily infected now. Nasik, I understand, this year has been infected from one single imported case, whereas the previous year it took at least 40 imported cases to infect the town." We may remark that the particular case of Nasik does not seem to lend any real support to Major Anderson's case, inasmuch as it appears that 26 of the 36 imported cases which were detected in Nasik before plague became indigenous in October 1897 were cases which had been imported from the neighbouring town of Igatpuri. Quite apart from any question of a superior infectivity of cases of plague imported from neighbouring localities, the probabilities were manifestly greatly in favour of Nasik becoming infected from Igatpuri. Major Anderson, however, came to the conclusion that the risk of infection spreading from an imported case was associated, not so much with the fact of the patient suffering from an eminently infectious form of plague or not, as with the fact of his coming from a locality where the conditions were similar to those of the place into which he introduced the infection. Thus, he considered that an imported case from Bombay would not be so likely to affect Nasik town as a case imported from the Nasik district itself.

Resolution of the Government of Bombay, No. 3941 P., 17th June 1899.

Observations by Mr. Lord and Mr. Hudson regarding acclimatisation of plague bacillus in Ahmednagar district. 18,998–19,005.

380. Mr. Lord, who was employed in the Ahmednagar district, had formed an opinion quite similar to that of Major Anderson. He had, on mentally reviewing the origin of plague outbreaks in the district in question, noticed that cases imported from Poona appeared to have taken root much more easily in Ahmednagar than imported cases from Bombay. He expressed his belief that every case imported from Poona or Sirur into the Ahmednagar district led to an outbreak. With reference to this circumstance he observed: "My private opinion is that the bacillus from below the Ghats had got to be acclimatised in a damp place, because Poona is a damp place, and so is Igatpuri, more or less, and then Sirur was a little drier, and so the infection was brought gradually to a place in a condition in which it could live. I believe the same thing has been noticed in the Broach district, because cases taken straight from Bombay to Broach did not seem to spread. But when cases were brought into Broach from Ankleshwar, which is just south of Broach, the plague spread at once. I believe there had been several imported cases from Bombay direct into Broach which did not spread."

24,110. It is to be noted, in connexion with the opinion formed by Mr. Lord, that Mr. Hudson, who had also been employed in plague operations in the Ahmednagar district, had not noticed any difference in the infectivity of plague cases imported from neighbouring places, as compared with the infectivity of plague cases imported from a greater distance.

Facts relating to epidemics in Rajputana and Hyderabad State that support the acclimatisation theory.

381. In addition to the observations which have been cited above, there are also other observations which would seem to lend support to the theory of acclimatisation. Among these is the fact that, though numbers of residents of Rajputana fled to their homes on each occasion upon which plague became severe in Bombay, only one small outbreak of plague has occurred in that extensive tract of country. Again, in spite of the fact that many thousands of people dispersed over the country when Sholapur was evacuated, as many as 5,000 of these making their way into the town of Gulberga in the Hyderabad State, the furthest point to which the infection is known to have been carried was not more than 60 or 70 miles from Sholapur.

Instances of the occurrence of plague outbreaks apart from any preliminary acclimatisation of plague bacillus.

382. Observations such as these would appear to conform with the view that the plague bacillus, when carried into parts of the country remote from the original source of infection, may find in the change of environment an influence unfavourable to its survival. The facts, however, do not point in a uniform manner in this direction. Isolated instances pointing in a contrary direction are on record. We may instance the cases of Palanpur, of the village of Khandraoni in the Gwalior State, of Teuri in the Sirohi State, and, further, the case of the village of Sangwi and two adjoining 22,093. villages in the Satara district, where plague epidemics broke out immediately after an imported case had arrived from a distant part of the country. Here, though we may explain the fact to ourselves by assuming that the local conditions in the place into which the infection was imported may, at the date of importation, have been essentially

similar to those of the infected centre from which the infection was imported, it would seem certain that no preliminary adaptation of the bacillus can have been required.

Bacteriological observations bearing on acclimatisation theory.

383. Before dealing further with the epidemiological observations which may come into consideration in connexion with this question, we shall perhaps do well to turn and inquire whether any bacteriological facts have come to light which would lend any countenance to the theory of acclimatisation espoused by Major Anderson and Mr. Lord. A body of bacteriological facts, which may be brought into relation with the problem which presented itself to these observers, is set forth in a recent paper by Danyz, which deals with the application of bacteriological methods to the destruction of rats. With a view to the practical exploitation of such methods, Danyz addressed himself to the task of modifying a particular species of coli bacillus which was pathogenic for rats, in such a manner as to obtain a culture which should produce a fatal septicæmic infection in these animals when administered to them in food. After having determined, in a series of preliminary experiments, that this object could not be achieved by making a series of passages in which the bacillus was inoculated directly into the rat organism, and having further determined that the cause of failure was, here, the fact that the increased capacity for growing in the organism which was in the course of these hypodermic passages acquired by the bacillus did not go hand in hand with a capacity for maintaining its vitality in the alimentary canal, Danyz preceeded to apply a twofold process of selection. He selected, in the first place, from among the bacteria which produced fatal results when hypodermically inoculated, those varieties which succeeded in adapting themselves to conditions which resemble, to some extent, those found in the alimentary canal. From among these were again selected those varieties which manifested the greatest power of growing in the interior of the organism proper. By a judicious alternation of these two main principles of selection, Danyz obtained a micro-organism which possessed at one and the same time an increased capacity for growing in the organism proper and an increased capacity for surviving in the alimentary canal. By means of food infected with this bacillus, Danyz succeeded—it is beside our present purpose that many others who have been provided with the Danyz bacillus have since failed—in producing a fatal septicæmic disease among the rats in a section of the Paris sewers, which was specially shut off for the purposes of this experiment.

Annales de l'Institut Pasteur, April 1899.

The general principle underlying the procedure adopted by Danyz would appear to have a very great epidemiological importance. It would seem, in particular, to have a great importance in connexion with the epidemiology of plague, since we may assume that the spread of this disease necessarily involves, on the one hand, a capacity on the part of the specific bacteria for cultivating themselves in the organism, and, on the other hand, a capacity on the part of those bacteria for surviving in a fully virulent condition in the particular environment in which they find themselves after they have escaped from the infected organism. The possession of such entirely different sets of attributes is obviously intelligible only on the basis of a dual process of adaptation on the part of the plague bacillus, an adaptation, on the one hand, of the plague bacillus to growth within the human organism, and an adaptation, on the other hand, of the bacillus to survival in a fully virulent condition in the particular external environment of the infected locality. Now, since this external environment varies from place to place, and from one season of the year to another, it is obviously conceivable that one of the essential preliminaries of an epidemic outbreak of plague in any place may be the adaptation, or "acclimatisation" of the bacillus to the external conditions obtaining for the moment in that particular place.

Epidemiological observations which are in conformity with the acclimatisation theory.

384. Having gathered, from a general biological consideration of the question, the general bearings of the "acclimatisation theory," we may come back once more to the question of the conformity of the theory with the epidemiological observations which have been made in India in connexion with plague. In this connexion we may advert to the following points: —

(1.) The slow rate at which plague has spread through India, so far as it has not been conditioned by the factors considered in a previous section of this Chapter, would be satisfactorily accounted for by the "acclimatisation theory."

(2.) The general circumstance that in infected places, almost without exception, epidemics of plague have alternated with periods of freedom, or relative freedom, from plague, would conform with the theory, inasmuch as it must be assumed that the external conditions may at one time be favourable, and, at another time, unfavourable, to the survival of the bacillus in a virulent form outside the human organism.

The seasonal variation of plague would find its explanation in this circumstance. In particular the fact that the plague epidemic which occurs in the latter part of the cold weather dies out in the altered meteorological conditions which are associated with the advent of the very hot weather (in Northern India generally), or with the advent of the rains (in Bombay and Southern India generally), suggests that a plague bacillus which is adapted for surviving in a particular external environment under the conditions which obtain in the cold weather, is not adapted for surviving in that external environment in the altered conditions of the extreme hot weather, or the rains. Similarly, the fact that the curve of plague mortality rises to a second maximum in the latter part of the rains and goes down again when the cold dry weather supervenes, seems to suggest that a plague bacillus can indeed adapt itself to the external conditions which obtain in the rains, but cannot adapt itself to this set of conditions without forfeiting the power of flourishing outside the organism under the external conditions which are associated with the cold weather.

(3.) Again, the circumstance that plague has in some places not spread to any serious extent, while in others it has been severely epidemic, though at the same time it has manifested itself in both in an equally virulent and fatal form,—Calcutta and Bombay may be usefully contrasted from this point of view,—seems to suggest that in the external conditions there may be something which, in the one case is favourable, and in the other unfavourable, to the survival of the plague bacillus outside the organism. We may remark, in passing, that while in India we made some preliminary investigations, which did not lead to any positive results, to determine whether there was any marked difference in the bacterial flora of the soil of the two cities we have just referred to.

(4.) The circumstance that in Bombay, Poona, and certain other places, the later epidemics have exceeded the earlier ones in severity, seems to suggest that a process of gradual acclimatisation of the bacillus to the external conditions of these places may have been in progress. In suggesting that this interpretation may be placed upon the facts, we have not lost sight of the circumstance that the increasing severity of the successive epidemics may possibly, to some extent, find its explanation in the gradual wider diffusion of the infection in the localities in question.

(5.) Some of the seemingly paradoxical facts, considered above in connexion with the influence of insanitary conditions on plague, may possibly be explained in the light of the theory we are considering. Among these may be enumerated (*a*) the fact that plague has not become severely epidemic in the towns of Calcutta, Mysore, or Oporto, where the evidences of every kind of sanitary neglect are to hand on every side; (*b*) the fact that plague was more rife in the less crowded suburban districts of Bombay than in the overcrowded districts in the centre of the City; and (*c*) the fact that plague claimed considerably more victims in the well-ordered and sanitary surroundings of the Byculla Gaol, Bombay, than in some of the most insanitary and overcrowded chawls in the City. These facts, which at first sight appear so paradoxical, are brought nearer to the understanding, if we reflect that the survival of the plague bacillus in a virulent condition in the external surroundings of insanitary chawls is very far from being, as has been often tacitly assumed, a mere matter of course. On the contrary, there are greater difficulties in imagining that the plague bacillus could adapt itself to the protean surroundings of overcrowded insanitary chawls (differing as these do widely among themselves) than in conceiving of the bacillus adapting itself to comparatively simple external conditions which are common to clean houses as a class.

(6.) Lastly—but here we are treading, if possible, on more uncertain ground—it would seem as if we were entitled to draw certain inferences which are appropriate to the question now under review, from the consideration of the past history of plague, both in India and in other countries. Plague, after being prevalent for a period of years, has, in the past, always gradually diminished, and (except in certain endemic centres) finally become extinct. It would seem from this that in certain cycles the external conditions (we have of course no knowledge as to what particular external conditions are involved) must be relatively favourable to the survival of the plague bacillus outside the body, and that then in certain other cycles (and it is legitimate to hope for the advent of these in India) the external conditions become again relatively unfavourable to the survival of the plague bacillus outside the body, and, therefore, to the spread of plague.

The President being unable to agree with many of the suppositions and statements in this paragraph has expressed his views separately.

The President is unable to agree with many of the suppositions and statements contained in this paragraph (384). His views have been expressed in a separate Memorandum. (Appendix III., *see* paragraphs 47–52, 41–43, 84, 13, 11, 59–64.)

CHAPTER IV.

HAFFKINE'S ANTI-PLAGUE INOCULATION.

I.—REVIEW OF HISTORY OF PREVENTIVE INOCULATION.

Preliminary review of preventive inoculation.

385. It will be of advantage, before we deal specifically with the particular question of Mr. Haffkine's Anti-Plague Inoculations, very briefly to review the history of preventive inoculation. We shall, in the course of our survey, see that general principles have gradually established themselves, first in connexion with the question of the application of preventive inoculation in different kinds of diseases, and secondly in connexion with the question of the procedure which must be adopted to secure the maximum of advantage from such preventive inoculation.

Inoculation against small-pox.

386. The first step in the application of the method of preventive inoculations was taken when the process of inoculation against small-pox was introduced into Western Europe from Turkey in the early part of the last century. In the case of this inoculation, the virus of small-pox, was directly transferred from the patient who was suffering from a clinically mild attack of small-pox into the person who was to be protected. This method of inoculation was resorted to in the expectation that the patient who was inoculated in this manner would, like the patient who had suffered from an actual attack of small-pox, be thereafter immune against further attacks of the disease. This particular expectation was fulfilled. On the other hand, experience showed that, as a set-off against the advantages which accrued to the patient, a considerable risk had to be run. Severe, and in some cases fatal, attacks of small-pox not infrequently supervened in the persons who submitted themselves to inoculation.

Principles established.

The principles which can be deduced from the experience of this, the first, system of preventive inoculation are the following :—

I. Given the case that we are dealing with an infective disease of which one attack protects against a subsequent infection, it is possible to protect against that disease by inoculating some of the virus derived from a sick patient into a previously unprotected person.

II. Given that the virus which is inoculated is not sufficiently attenuated, the evils which result from such preventive inoculation may, in some cases, exceed the benefits which will be derived.

Inoculation with cow-pox lymph.

387. The first system of preventive inoculation, in which a duly attenuated virus was used, was the system of preventive inoculation with cow-pox lymph, which was introduced by Jenner. In this case, the virus which is inoculated is, as subsequent researches have shown, the *materies morbi* of small-pox, which has undergone a constant and adequate degree of attenuation in the course of its passage through a series of calves. From the experience of the favourable results which have been obtained by this system of preventive inoculation, the following principle can be deduced :—

III. Given that the virus of a particular disease can be obtained in nature in a constant and sufficient degree of attenuation, that virus may be employed as a vaccine.

Pasteur's researches on anthrax.

388. The next great practical advance, in the matter of preventive inoculation, was taken when Pasteur demonstrated that, in default of a naturally attenuated virus it was possible by artificial means to obtain the attenuated viruses which are required. Pasteur showed in the case of anthrax that it was possible to attenuate the virus to any desired degree. Further, he showed how the degree of attenuation could be accurately measured on animals. Lastly, Pasteur showed that it was possible, by employing measured quantities of such duly attenuated cultures, successfully to vaccinate animals against anthrax.

The principle which was thus established may be formulated as follows :—

IV. Given that we have at disposal in nature only a virus whose virulence is such that its inoculation would entail risks too formidable to be faced, still, if it is practicable artificially to attenuate that virus, the attenuated virus may then be used without risks as a vaccine.

With the establishment of this principle, finality would appear to have been reached in the matter of the *essential* requisites of those living vaccines which Pasteur had in view.

Purity of vaccine an essential condition.

389. In order that we may have an ideal vaccine material, we need only stipulate in addition, first, that the menstruum in which the actual vaccine material is contained shall be quite free from bacterial contamination, and secondly, that such menstruum shall, as far as possible, be free from any toxic substance which is not operative in the direction of producing immunity.

Ferran's inoculation against cholera with living cultures.

390. Having placed these theoretical requisites clearly before us, we may consider the next extension which was made in the matter of the application of preventive inoculation to man. This step was taken in Spain in the presence of the cholera epidemic, which devastated certain regions of that country in 1885. This step consisted in the application of the principle of preventive inoculation to the protection of the population against this disease. The anti-cholera inoculations which are in question were introduced by Dr. Ferran. The method of operation consisted in the inoculation of living cholera cultures. These inoculations were very widely applied. An inquiry into them was instituted by a Commission appointed by the French Academy of Medicine. The scope of this inquiry embraced: (*a*) the methods which were employed in the manufacture of the vaccine, and (*b*) the results which were obtained by the inoculation.

Bulletin de l'Académie de Medicine, 1885, pp. 902–33.

It appears from the Report of the French Commission, that Dr. Ferran refused to reveal the details of the methods which he employed in the preparation of his vaccine. The vaccine appears to have been manufactured by growing the cholera bacillus in nutrient broth. The methods which were employed in making these cultures are described as having been crude in the extreme. It would appear that no method of standardizing the strength of the culture and no process of controlling the purity of his culture was adopted by Dr. Ferran.

The members of the French Commission saw a considerable number of persons inoculated with Dr. Ferran's vaccine. They examined these patients after inoculation, and they reported that they did not observe, and that they had not learned of, the occurrence of any evil symptoms beyond the fever and the malaise and local pain, which are the necessary accompaniment of such inoculations. Dr. Ferran's statistics were not controlled by the French Commission. The Commissioners, however, state that they learned incidentally from a fellow passenger in the train that these statistics were probably untrustworthy, inasmuch as there was a considerable concealment of deaths in the cholera districts, and inasmuch as the population of Spanish towns was habitually understated by the Municipalities, with a view to evading the poll tax.

General deductions from Ferran's inoculations.

391. These inoculations of Dr. Ferran have an interest, inasmuch as they represent the first extension of the principle of preventive inoculation to the protection of man from diseases other than small-pox. The principles which underly these inoculations may be formulated in the following way :—

V. Given that we are dealing with a disease, such as cholera, which does not itself confer any long-lasting immunity against a subsequent attack, it is still an object to be aimed at to obtain, by a vaccination process, the short-lived immunity which accrues to a patient who has survived an actual attack of the disease.

VI. In a disease, such as cholera, which is caused by micro-organisms, which have no power of proliferating themselves in the blood or tissues of man, the vaccine material which is hypodermically inoculated may legitimately consist of unattenuated living cultures of such micro-organisms.

From the results of Dr. Ferran's inoculations, so far as they are available to us, we may glean also the following facts for our guidance :—

(*a*.) Even in the absence of all scientific precautions for controlling the purity and the virulence of the cultures which are employed, the evil effects which might have been anticipated do not necessarily supervene.

(*b*). No certain judgment can be arrived at with regard to the efficacy of an inoculation process when the statistics are liable to be extensively vitiated, on the one hand, by insufficient reporting and the concealment of cases, and, on the other hand, by false estimates of the numbers of the non-inoculated population. Both these factors are said to have vitiated the statistics of the anti-cholera inoculation in Spain: we shall find them detracting from the value of many of the statistics of anti-plague inoculation which were placed before us in India.

392. Almost contemporaneous with Dr. Ferran's work in connexion with the cholera inoculation, is the brilliant original work which Pasteur did in connexion with the elaboration of a method of protective inoculation against hydrophobia. The details of Pasteur's process, and the new principle which can be deduced from it with regard to the possibility of inoculating successfully during the incubation period, do not immediately here concern us. The question of successful inoculation during the incubation period, so far as it has an application to the case of plague, will be dealt with later. Suffice it for our purpose that Pasteur's work in connexion with rabies provides us with a further instance of a possibility of conferring protection against an invariably fatal disease by the employment of a duly-standardized living vaccine.

Pasteur's work on rabies.

393. The next advance in the history of preventive inoculation is marked by the fact that Mr. Haffkine, who was inspired by the principles of Pasteur, took up the anti-cholera work which had been inaugurated by Dr. Ferran. Mr. Haffkine laid down for himself as a principle that in the case of the anti-cholera inoculations the Pasteurian prescription of operating with measured quantities of bacteria of accurately known virulence was to be strictly observed. The vaccination-dose of cholera bacilli employed by Mr. Haffkine was the quantity of culture which grew in 24 hours on one-sixth part of the surface of an ordinary agar tube. The virulence of the cholera cultures which were employed for these inoculations was such that the total peritoneal effusion of a guinea-pig, which had been killed by intra-peritoneal injection of cholera, was lethal to another guinea-pig in eight hours.

Haffkine's inoculation against cholera with measured quantities of living bacteria of known virulence.

394. Reports showing favourable results which were obtained from these inoculations have been published, on the one hand by Mr. Haffkine, and on the other hand by Captain Christian Hare, I.M.S. Inasmuch as these favourable results were obtained in persons who were exposed to cholera infection within a very short period after the inoculation, they tell us nothing with regard to the duration of immunity. A painstaking endeavour was made by Mr. Haffkine to collect data upon this subject by investigating the incidence of cholera among inoculated persons who were residing in the bustees of Calcutta, where cholera is endemic. In accordance with the results of these inquiries, the resulting immunity was adjudged to last for over 12 months. In the case of the epidemic of cholera which occurred in the East Lancashire Regiment in Lucknow, 14 months after inoculations had been done in this regiment by Mr. Haffkine, the incidence of the disease showed that such immunity as was conferred by the small quantities of cholera cultures inoculated was hardly noticeable.

Duration of immunity against cholera doubtful.
"Indian Medical Gazette," No. 1, January 1895.
Report to Government of India, dated Aug. 25th, 1895.
"Indian Medical Gazette," Vol. XXX., No. 12, December, 1895.

395. The next practical extension of the principle of preventive inoculation was made when the anti-typhoid inoculations were introduced. The first of these inoculations were undertaken by one of us in July and August 1896. A little later similar inoculations were undertaken by Pfeiffer and Kolle in Germany. In both cases the immunizing material which was recommended consisted of dead cultures of typhoid bacilli. In view of this fact, it was possible directly to standardize the vaccine by determining the toxicity of a measured volume of the dead culture. It has been determined by comparative experiments on men and animals that the quantity of dead culture which may with safety be inoculated into a man is the quantity of broth culture which is lethal for 100 grammes of guinea-pig.

Inoculation against typhoid, with dead cultures.
"Lancet" Sept. 19th, 1896,
"British Medical Journal" Jan. 30th, 1897.
"Deutsche medicinische Wochenschrift" Nov. 12th, 1896.

396. Next in chronological order comes preventive inoculation against plague. The first experiments made on this subject were made by Yersin, Calmette, and Borrel conjointly in 1895. These observers found that it was possible to confer a certain amount of immunity against plague by the hypodermic injection of dead cultures of plague bacilli. Their experiments were carried out on rabbits and guinea-pigs.

Mr. Haffkine's anti-plague inoculations represent an extension of this system of preventive inoculation to men.

Haffkine's inoculation against plague.
Annales de l'Institut Pasteur. 1895.

II.—Preparation and Character of Haffkine's Vaccine.

397. We may consider in connexion with Mr. Haffkine's method of inoculation—

I. The method of preparing mass cultures of the plague bacillus.
II. The method of controlling the purity of these cultures.
III. The method of killing the plague bacilli with the view of converting the culture into an immunizing material.
IV. The method of decanting and bottling the prophylactic fluid.

Questions to be now considered in connexion with Haffkine's anti-plague vaccine.

V. The method of ascertaining that the vaccine is free from contaminating micro-organisms, and the precautions which are adopted for preventing the growth of such organisms.
VI. The method of standardizing the vaccine.
VII. The composition of the vaccine.
VIII. The volume of the prescribed dose.

II.(1.) *Method in use for the Preparation and Standardization of the Vaccine.*

I.—Method of preparing mass cultures of the plague bacillus.

398. In preparing cultures of the plague bacillus on a large scale, Mr. Haffkine had to deal with two difficulties. In the first place he had to exclude from his culture medium all animal products, such as commercial peptone, of which it could not be asserted that they had been prepared in such a manner as to be inoffensive to the feelings of the natives of India. In the second place, Mr. Haffkine had, while cultivating his plague bacillus in mass culture on a liquid substratum, to provide for the efficient aeration of his cultures. Both these difficulties have been overcome.

Culture medium adopted. 26-7.

A suitable culture medium has been obtained by digesting goat's meat in the autoclave at 140° C. with hydrochloric acid, and then neutralizing the acid medium with caustic soda.

Method of securing adequate aeration. 27.

The difficulty which is occasioned in the case of any fluid culture medium by the want of proper aeration in the deeper layers is overcome in the case of Mr. Haffkine's mass cultures by the introduction of a small quantity of oil into the medium. The plague bacteria suspend themselves from the oil drops on the surface of the medium.

Method of cultivation. 27.

The culture medium is inoculated with plague bacilli. This done, the inoculated flasks are cultivated at the temperature of the air. When this temperature sinks below 25° C., the air of the room is warmed up by lighting a certain number of gas jets. The flasks are cultivated in this manner for a period which varies from two to six weeks. During the course of the cultivation, the culture is shaken up every few days.

II.—Method of controlling the purity of the plague culture. 17,276.

399. At the termination of the cultivation, the purity of the plague culture is controlled by transferring a portion of the contents of the flask with a sterile pipette on to the surface of a dry agar tube. The character of the growth which develops on the dry agar tube is then controlled by naked eye observation. The character by which the purity of the culture is judged is the specular appearance of the colonies, when these are seen from the back by reflected light through the thickness of the agar.

III.—Method of killing the plague culture and precautions taken to prevent the growth of contaminating micro-organisms is the vaccinating material. 102·4.

400. After drawing off a sample of the contents for the purpose of controlling the purity of the culture, the cultivation flasks are placed in a water bath along with a control flask. This last is filled with water, and is fitted with a thermometer. The temperature of the water bath is then raised until the thermometer in the control flask indicates a temperature of 65° C. This temperature is maintained for one hour. An addition is then made to each flask of a quantity of carbolic acid amounting to one two-hundredth part of the bulk of the vaccine.

IV.—Method of decanting and bottling. 17,461-6.

401. The decanting and bottling is effected in the following manner. The decanter takes a flask of the dead plague culture and shakes up the sediment which has lodged at the bottom of the flask. He then raises the cotton-wool plug and introduces into the neck of the flask a long glass syphon. There appears then to be some difficulty in starting this syphon. The method which is enjoined involves the fitting on of a mouthpiece to the end of the syphon, and the application of suction. The syphon having been started, the contents are run off into ordinary 4 to 6 oz. narrow-necked and dark-coloured medicine bottles. These are then corked up with corks that have undergone a sterilization process. This done, the necks of the bottles are immersed into a vessel full of melted sealing wax. During the process of decantation, the decanters are instructed to shake up the vaccine material from time to time.

V.—Method of controlling the sterility of vaccine. 17,470-2. 104.

402. It was assumed that the sterility of the vaccine was sufficiently insured by the procedure described above until attention had been drawn to this matter shortly after we commenced our inquiry in India. Since December 12th, 1898, the sterility of the culture has been directly controlled by transferring to a tube of agar the first sample of the carbolized vaccine syphoned off from the cultivation flask.

VI.—Method of standardizing the vaccine.

403. We had some difficulty in ascertaining what was the method of standardization which was adopted by Mr. Haffkine.

72, 77, 78, 182.

We gathered, from Mr. Haffkine's statement when he was first examined before us, that each brew of vaccine was standardized either by Mr. Haffkine himself or by the inoculator by determining what volume of the vaccine would produce an average temperature of 102° F. in a series of ten to twenty patients. Further inquiry, however, revealed that this method of standardization was not systematically employed. On the one hand it was ascertained that Mr. Haffkine was not himself able to carry out this 3023-8. system of standardization in the case of the large bulk of the vaccine which was sent out, and on the other hand we were able to see clearly that the conditions under which the inoculations were done at outlying stations were such that it was not possible for the inoculator to undertake this preliminary task of standardizing his vaccine on a series of patients. Finally, we elicited that the routine practice which was adopted 17,527-46. in Mr. Haffkine's laboratory was to standardize the vaccine by holding up to the 26,467. light one or two sample bottles of each brew, with a view to appreciating the opacity of the vaccinating fluid. It was in conformity with the results of this appreciation that the dose was inscribed on the label of each bottle of the vaccine. The dose was there stated on the labels in multiples of a "standard dose." This "standard dose" 4,577. 10,705-6. 33, 4002. was an arbitrary quantity: it was assumed to be the equivalent of $2\frac{1}{2}$ c.c. of the original vaccine with which Mr. Haffkine inoculated himself and his first batch of patients. Where, for instance, two or three standard doses were prescribed, it was assumed that the vaccine of which this quantity was prescribed was twice or thrice weaker than the original vaccine.

Factors which in practice acted as checks on the method of standardization adopted.

404. While it appears from the evidence which has been placed before us that the above is the routine practice which was adopted in the standardization of the vaccine, it is to be observed that the results which were obtained by this method were, in some instances, controlled by direct observations of toxicity made on persons who presented themselves for anti-plague inoculation at the inoculation station which was attached to Mr. Haffkine's laboratory. 78. We may also note that Mr. Haffkine throws the ultimate responsibility for the standardization of the vaccine upon the inoculator, inasmuch as he has given it to be understood that each inoculator, before he proceeds to inoculations *en masse*, should make, in the case of a sample of vaccine, a preliminary series of test experiments with the prescribed dose on a batch of some twenty patients.

VII.—Volume of the prescribed dose.

405. The samples of the vaccine which have come under our direct observation have been estimated by Mr. Haffkine to be respectively 2, $2\frac{1}{2}$, 3, 4, 5, 6, 7, and 8 times weaker than the standard vaccine. The doses of these vaccines were thus respectively 5, $6\frac{1}{4}$, $7\frac{1}{2}$, 10, $12\frac{1}{2}$, 15, $17\frac{1}{2}$, and 20 c.c. On an average the prescribed dose has perhaps amounted to something like $7\frac{1}{2}$ c.c.

VIII.—Composition of vaccine.

406. The vaccinating material consists of two constituents. By far the larger bulk consists of the nutrient fluid in which the plague bacilli have been grown. Relatively speaking, a very small bulk consists of the dead bodies of the plague bacilli which have 27. been grown in that fluid.

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II.(2.) *Criticism of Method employed for Preparing the Vaccine and sending it out for use.*

Criticisms of method adopted for preparation of vaccine.

407. Before passing on to make any criticisms of the methods which are adopted in the preparation of the vaccine, we desire to recognise in the fullest manner the enormous difficulties with which Mr. Haffkine had to contend in working under the conditions of an Indian climate, with an incompletely trained staff, in an incompletely equipped laboratory, and under the pressure of great urgency.

(I.) Method of preparing mass cultures.

408. It seems to us that Mr. Haffkine has solved in a skilful manner the problems of finding a suitable culture medium and a suitable method of aerating his mass cultures of the plague bacillus. A somewhat similar method to that which he has employed for suspending the plague bacilli on the surface of the nutrient fluid has frequently been employed in the cultivation of the diphtheria bacillus.

(II.) Method for controlling purity of cultures.

409. Mr. Haffkine's method of controlling the purity of his mass cultures is the routine method which is adopted by all bacteriologists, and calls for no remark. The method of controlling the purity of the cultures of the resulting growths merely by naked eye inspection is, on the other hand, a departure from the usual method which is adopted in such cases. The specular appearance of the colonies of plague bacilli, seen from behind by the reflected light through the depth of the agar, is a characteristic upon which we should scruple to place much reliance. Our experience in this matter 8667. is the same as that of Mr. Hankin. Hence we do not think that this method of controlling the purity of a plague culture is one that ought to be generally adopted. We are, however, very far from disputing that the character referred to may, in the hands of a bacteriologist who has the special experience of Mr. Haffkine, constitute a trustworthy index of the purity of the plague culture.

(III.) Method of killing the plague culture.

410. The method for killing the cultures of plague bacilli, which has been adopted by Mr. Haffkine, is the routine method which is adopted by every bacteriologist. In view of the fact that no surviving plague bacilli have been detected either by ourselves or by others in very numerous samples of vaccine which have been examined bacteriologically, the method of killing the culture which is adopted by Mr. Haffkine appears to us to be, in the case of plague, as in the case of other non-spore bearing organisms, absolutely trustworthy.

Influence of heating on the bacterial sediment and the supernatant fluid respectively.

The only question which has to be considered in connexion with the application of heat for the purpose of killing the plague bacilli is the question as to the influence which the temperature employed may exercise upon the various constituents of the prophylactic fluid. Experiments upon this question have been made by the German Commission and by ourselves.

Report of German Plague Commission, pp. 312-4.

The German Commission found that the efficacy of the immunizing substances which are contained in the bacterial sediment was perfectly well preserved when the bacteria were killed by an exposure to a temperature of 65° C. The protective power of the bacteria which were killed by the application of that temperature was not less than the protective power of an equal bulk of bacteria which had been killed by chloroform. The immunizing powers of the bacterial sediment were, however, practically destroyed when this sediment was subjected to a temperature of 100° C.

26,432

We, for our part, have tested the effect which is exerted by heat upon the filtrate from a plague culture. These results have been incorporated in Table IV. of Dr. Liston's evidence. It results from these experiments that the soluble toxins, which are under certain conditions developed in the fluid nutrient medium in which the plague bacilli are grown, are apparently not affected by exposure to a temperature of even 100° C.

109. Mr. Haffkine has not made any experiments on this subject.

Effect of addition of $\frac{1}{2}$ per cent. carbolic to the vaccinating material.

Further, in this connexion we may consider the effect which is produced by the addition of carbolic acid to the vaccinating material.

Report of German Plague Commission. pp. 310-2.

So far as we know, the only experiments which have been made with a view to ascertaining the effect of such an addition, are the experiments on the effect of an addition of $\frac{1}{2}$ per cent. carbolic acid to plague cultures, before and after heating, which were instituted by the German Plague Commission. Two facts were brought out by these experiments. The first of these is that the protective properties of a plague culture which has been killed off by the application of heat are not in any way impaired by the subsequent addition of $\frac{1}{2}$ per cent. carbolic acid. The second of these is the very interesting fact that when $\frac{1}{2}$ per cent. carbolic acid is added to the unheated plague culture, its chemical constituents are so altered that it becomes perfectly useless from the point of view of giving protection.

120. Mr. Haffkine has not made any accurate experiments on the effect of the addition of the carbolic acid which he makes to his vaccinating material.

(IV.) Method of decanting and bottling.

411. It is manifest that the procedure of decanting and bottling which has been outlined above, and which is prescribed in detail in the instructions which are incorporated in Appendix No. V. in Vol. I. of our Proceedings, is a procedure which even a skilful operator could not easily carry out in an absolutely aseptic manner. The chances of contamination must naturally be materially increased when it becomes necessary to commit the task of carrying out these instructions to a subordinate native agency. The particular difficulties which we have noticed are:—

1st. The difficulty of ensuring the adequate sterilization of the glass syphon.

2nd. The difficulty of ensuring that the syphon shall be started by the prescribed procedure without contaminating the end of the delivery tube.

3rd. The difficulty of corking a bottle in an aseptic manner when the cork has to be held and inserted into the neck of the bottle with no other implement than a pair of ordinary dissecting forceps.

Lastly. The difficulty of sealing a bottle in an airtight manner with a material such as sealing wax, which refuses to adhere to a wet or steamy glass surface.

II.(3) *Question of the Sterility of the Vaccine.*

(V.) Method of securing sterility of vaccine.

412. The above criticisms of the methods of the preparation, decanting, and bottling of the vaccine, acquire importance in view of the fact, which we will now proceed to consider, that the precautions taken did not, in point of fact, secure the freedom of the vaccine from contaminating micro-organisms.

Question of the presence of contaminations in the

Evidence bearing upon this question was brought before us first at Dharwar. It was there brought to our notice that, in view of the fact that certain bottles of vaccinating material. 1754–7, 1781, 1807–9.

vaccine had been found to be putrid, it was the practice of the inoculators to smell each bottle of the prophylactic, with a view effectually to exclude such bottles.

5161, 5379–95 5674, 5762–77, 5914–25.

The question of the presence of contaminating micro-organisms in the vaccine was again brought before us at Hyderabad, by Col. Lawrie, I.M.S., and Mr. Mullanah. We found some difficulty in determining who was really responsible for the experiments which were adduced in the support of this assertion, that the vaccine was contaminated. We have, however, in view of the fact that Dr. Lawrie controlled the processes and deductions of Mr. Mullanah, finally arrived at the conclusion that the responsibility for these must rest with Dr. Lawrie. This being so, we are compelled, in view of the want of familiarity with bacteriological methods which was displayed by Dr. Lawrie, to receive the experimental data, which were brought before us, with a certain amount of reserve.

5798–821. 24,895–916. Appendix LXX. in Vol. III. of these Proceedings.

In addition to the evidence just referred to, evidence on the subject of the contamination of the vaccine was brought forward both in Hyderabad and afterwards in Bombay by Captain C. A. Johnston, I.M.S. This evidence related to a series of seven bottles of Haffkine's prophylactic fluid which were bacteriologically tested. The samples which were employed for the purpose of testing these bottles were drawn off in the bacteriological laboratory at Hyderabad in the presence of one of us. While we are not able in this particular case to guarantee the absolute asepticity of the procedure which was adopted in transferring the vaccine to the agar tubes, there can be no doubt that the luxuriant growth which was to be seen when these agar tubes were afterwards produced for our inspection could not possibly be accounted for by the minor defects which were noted in the procedure adopted. The bacteria which were obtained by Captain Johnston from one of these samples (Brew No. 5,338) were afterwards inoculated into a rabbit, with fatal results.

6300–92.

Our attention was further directed to the possibly contaminated condition of the vaccine by the evidence which was laid before us at Wardha. The evidence in question showed that constitutional and local symptoms of excessive severity had supervened upon the inoculation of Mr. Hogan and his Assistant Surgeon with Mr. Haffkine's vaccine.

Bacteriological examination of samples of Mr. Haffkine's prophylactic at Calcutta and Bombay.

413. In view of the fact that doubt had thus been cast on the efficiency of the procedure adopted by Mr. Haffkine to secure the sterility of his vaccine, a series of samples of anti-plague vaccine were requisitioned from Dharwar, Bangalore, and Hyderabad. Sample bottles were also taken from the stocks which were kept at Nagpur and at Calcutta. Among the bottles which were taken from Nagpur were some samples of the brew of vaccine which, according to the information we have received, was the brew (Brew No. 4,746) employed in the inoculation of Mr. Hogan and his Assistant Surgeon. 8389.

These various samples of vaccine were submitted to bacteriological examination by Dr. Nield Cook at the Health Office, Calcutta, under the immediate supervision of one of ourselves. 8380–9. The methods which were employed in these examinations, and the details of the results which were obtained, will be found in Dr. Nield Cook's evidence. It will suffice here to note that out of a total of 22 bottles examined, seven were found to contain bacterial impurities. This total of 22 included six bottles which were sent in for examination from Hyderabad. One of these contained impurities. This bottle was derived from the same brew (Brew No. 5,338) which was III. 567. found by Captain Johnston to contain a bacillus which was fatal to rabbits. In two of the bottles which were derived from the brew (Brew No. 4,746), which had been employed for the inoculation of Mr. Hogan and his Assistant Surgeon, a number of contaminating bacteria were found. We may note in passing that the number of the brew, as it appears in Dr. Nield Cook's evidence, differs from the number assigned to this brew in the note in which Lieutenant Hammond, I.M.S., who also examined I. 460. certain samples of vaccine, details the result of his bacteriological observations. In view, however, of the fact that contaminating bacteria were found both by Dr. Nield Cook and by Lieutenant Hammond, and that they appeared on comparison to be morphologically identical, the confusion as to the number of the brew is not of any importance.

26,375.

A further series of 12 bottles, derived from the stock of vaccine which had accumulated at Mr. Haffkine's laboratory, was tested under our direct supervision at Bombay. Three of these bottles were found to contain contaminating micro-organisms.

17,481. Lastly, a methodical examination of all the brews of vaccine which were available in the Plague Research Laboratory, Bombay, was made by Captain C. J. Milne, I.M S., acting under the instructions of Mr. Haffkine. This systematic examination revealed the fact that out of 125 bottles examined 26 contained contaminating micro-organisms.

Thus, if we altogether exclude from consideration the evidence which emanated from Dr. Lawrie's laboratory, it is to be noted that the other series of examinations yielded the result that contaminations were present respectively in seven out of a series of 22, three out of a series of 12, and 26 out of a series of 125 bottles examined; in other words, contaminations were found in 36 out of 159, *i.e.*, in 22 5 per cent. of bottles examined.

Source of the contaminations discovered on bacteriological examination. 17,481. III. 645

414. In view of the fact that in Dr. Milne's series of examinations contaminations were found only in six out of 104 well-sealed bottles, whereas they were found in 20 out of 21 badly-sealed bottles, Mr. Haffkine has urged that the bacterial contaminations which we have spoken of above are almost all imputable to a defect of sealing in the bottles. We cannot, however, accept Mr. Haffkine's view in its entirety, for even when great precautions were taken to exclude all but well-sealed bottles—and such precautions were taken in the case of the bottles which were examined under our supervision at Calcutta and Bombay—the result showed that contaminations were present in 10 out of 34 of these well-sealed bottles. It seems to us, therefore, that many of the contaminations must have been introduced during the process of decantation.

Precautions for the avoidance of contaminations.

415. The questions which have been considered above, suggest two further questions:—

1. They suggest the question as to whether it would be possible to institute a final bacteriological examination with a view to the detection and exclusion of contaminated bottles.
2. They suggest the question whether, failing the adoption of such a process of bacteriological control, it would be possible to re-sterilize the vaccine after it is finally bottled.

Bacteriological control of sterility before vaccine is sent out not applied at period when most required, and does not detect bacteria not checked in development by presence of carbolic acid.

In connexion with these questions, we have to consider the procedure for controlling the sterility of the vaccine which has been adopted by Mr. Haffkine since December 1898. This procedure consists, as we have seen, in receiving directly on the surface of an agar tube the first portion of the carbolized vaccine which is syphoned off from each cultivation flask. It seems to us that this procedure hardly meets the necessities of the case. The following points suggest themselves to us in this connexion.

First, the proceeding is one which ensures the control of the vaccine only at that period when it least needs control, *i.e.*, at the period which immediately supervenes upon the process of heating and carbolization. On the other hand, it does not in any way guarantee the sterility of the vaccine at the stage when it most requires control, *i.e.*, at the period when it has been exposed to the risks of contamination which are involved in decanting, bottling, and corking.

17,302-6. A further criticism relates to the method which is adopted of testing the presence of contaminating micro-organisms in the vaccine material. It will have been noticed that the carbolized vaccine is received for testing purposes directly from the syphon upon the surface of the agar, and that it is not subsequently diluted. It seems to us that this method is a method which is calculated to reveal the presence of such bacteria only as are capable of growing in the presence of $\frac{1}{2}$ per cent. of carbolic acid. It may quite well be that these are the contaminations which are most to be dreaded. None the less, it seems to us that it would be better to adopt as a method of testing a method which would favour the development of each and every species of contaminating bacteria. This end might be readily achieved by taking the precaution of diluting the sample of carbolized vaccine which is to be tested, either before or after it is transferred to the surface of the agar tube.

Question of final re-sterilization of the vaccine in bottles. 24,917-21, 24,926-31.

In response to a suggestion which was made to Dr. Lawrie during his cross-examination before us, experiments on the re-sterilization of the vaccine in bottles, after they had been sealed up, were instituted by Captain C. A. Johnston. So far as these experiments go, we may note that their results are favourable to the conclusion that it would be possible by re-sterilization at a temperature of 60° C. to secure that the vaccine should be sent out in a perfectly aseptic condition, and this apparently without forfeiting anything of its efficacy.

II. (4.) *Question of the Standardization of the Vaccine.*

VI.—Method of standardization.

Two methods of standardization applicable.

416. We have seen above that it was laid down as a principle by Pasteur that no vaccination should be undertaken unless with a measured quantity of a culture of definitely ascertained virulence. The above, however, applies only in cases where a living culture is employed as a vaccine. In cases in which dead bacterial cultures are used as vaccine, the standardization of the vaccine resolves itself into a question of determining the toxicity of a measured volume of the culture. This determination may be made by directly testing the toxic effect of the dead culture on men or animals. Failing that, it may be made by determining in two successive operations, first, the virulence of the bacteria which are employed in the manufacture of the vaccine, and secondly, the quantity of effective element which is contained in a given volume of the dead culture.

Criticism of standardization by temperature reaction obtained in an inoculated patient.

Paras. 403-4 of this Report.

417. We have already stated that in some cases Mr. Haffkine's vaccine was standardized by the direct method of determining the toxic effect that was produced on man by the injection of a measured volume of the vaccine. Further, we have stated that it was contemplated that all of it should be standardized by this method. We may, therefore, consider the question of the standard of toxicity which was adopted. This standard was, as we have already seen, the production of an average temperature of 102° F. on a series of 10 to 20 patients.

With regard to this we have to state that we have no data at our disposal for arriving at a judgment as to whether the attainment of that temperature is, in reality, an index of the acquirement of immunity. It seems to us, however, on *à priori* grounds, that the temperature reaction is probably an untrustworthy index of the protection which is afforded, inasmuch as the vaccinating material contains, in addition to the poisons which are specific to the plague bacillus, other fever-producing poisons in the form of considerable quantities of peptone.

Practical difficulties in adoption of temperature reaction as standard.

17,490-5.

App. XIX in Vol. I. of these Proceedings.

Quite apart from the possible fallacies which attach to the particular criterion of efficacy which has been adopted by Mr. Haffkine, there seem to us to be also certain practical difficulties which are incident to this particular method of standardization. In the first place, the temperature reactions which supervene upon the inoculation of precisely similar quantities of one and the same vaccine are notoriously subject to very considerable individual variations. We may refer here to the evidence of Captain C. J. Milne, I.M.S., and the observations of Lieutenant Hammond, I.M.S. Secondly, the acme of the temperature apparently occurs at very irregular intervals after inoculation. Thirdly, it is very difficult to keep the inoculated under close medical observation for the time which is required for determining the ultimate height of the temperature.

3023-8, 6321-3, 10,803-7, 11,702-3, 14,805-10.

Confirmation of the truth of these conclusions was obtained by us as soon as we began to inquire into the question as to how far it had been possible in practice to employ the method of standardization which was prescribed by Mr. Haffkine. We found that in practically every case it had been found impossible to undertake the prescribed series of preliminary test temperatures. In connexion with this, we may remark that, with hardly an exception, the inoculator injected without question the doses of vaccine which were prescribed upon the bottles.

As soon as these facts came to our knowledge, during our tour in the Provinces, we recommended to the Government of India that the inoculator should be relieved from the task of standardization, and that all the operations which were required for the standardization should be carried out in the laboratory before the vaccine was sent out.

Criticism of standardization by estimation of opacity.

418. On our return to Bombay we made further inquiries as to how the dosage which was inscribed on the labels of the bottles was arrived at. Our inquiries revealed, as has already been stated above, that the doses were inscribed on the labels in accordance with the estimates which were formed of the opacity of the particular vaccines when certain sample bottles of these were held up to the light. In view of the fact that this method is not a procedure for directly testing the toxicity of a measured volume of vaccine, but a procedure which is designed to determine the quantity of bacterial sediment which is contained in a particular volume of fluid, it became necessary further to inquire, first, whether a preliminary method of standardizing the virulence of the culture was employed, and, secondly, whether the quantity of bacterial sediment contained in a measured volume of fluid was, as a matter of fact, accurately ascertained by the process which has been described above.

Question of antecedent estimation of virulence of cultures employed.

17,418-17,425.

419. The evidence which was laid before us by Dr. Mayr revealed the fact that no systematic method was adopted for ascertaining the virulence of the cultures which were employed for the manufacture of the vaccine. Mr. Haffkine had

previously stated that in lieu of adopting a systematic method of testing the virulence of his cultures, an endeavour was made to employ for the manufacture of the vaccine, so far as it was practicable, only microbes which were directly derived from the bodies of patients who had died of plague. No definite data were communicated to us by 27. Mr. Haffkine, but it appears, however, that it was not always possible to employ cultures which were directly obtained from plague patients. In many cases, as we gathered from Dr. Mayr's evidence, the microbes which were employed for the manufacture of the vaccine were microbes which had become attenuated in the course of prolonged cultivation on artificial media.

Doubt whether inoculation with attenuated plague cultures confers protection.

Report of German Plague Commission, p. 314.

420. We need not here, in the absence of sufficient experimental data, discuss the question as to whether protective effects can be obtained by the inoculation of non-virulent cultures. We may merely note that the German Plague Commission endeavoured to put this question to the test by experiments on two monkeys. Contrary to what had been found to be the case when sterilised cultures of virulent plague were employed, it was found that the sterilised cultures of non-virulent plague in similar quantities conferred no protection. The German Plague Commission based upon these experiments the conclusion: "That it is absolutely essential that the plague cultures which are employed in protective inoculation should be obtained directly from fatal cases of plague, and, failing that, they should be cultures which have been kept up to the necessary degree of virulence by a continuous series of passages through animals." The evidence for this conclusion does not seem to us to be absolutely cogent, inasmuch as evidence has not been brought forward by the German Commission to show that the quantity of bacteria on an agar culture of non-virulent plague is as great as the quantity which is contained on an agar tube of virulent plague. None the less until it shall have been established that protection can be afforded by vaccines made from non-virulent cultures, it seems to us that it would be desirable to adopt some method of keeping up the virulence of the plague cultures which are employed for the manufacture of the vaccine. The 26,434 C. results of the experiments which are recorded in the evidence of Lieutenant Liston, I.M.S., seem to us to indicate that it would be a comparatively easy matter to keep up the virulence of a plague culture by a series of passages through guinea-pigs.

Criticism of method adopted by Mr. Haffkine for determining quantity of bacterial sediment in given volume of vaccine.

421. From this we may pass on to the consideration of the method which is employed by Mr. Haffkine for determining the quantity of bacterial sediment which is contained in a given volume of the vaccinating fluid. It was obviously important to determine whether the method which was adopted was a method which gave approximately accurate results. This question is one which it seems to us must be kept rigorously apart from the question of the virulence of the particular cultures which are employed. For although it is possible that an error committed in the determination of the quantity of bacteria in a given bottle of vaccine might, in some cases, be counterbalanced by the fact that the virulence of the culture had, in a particular case, been over or under-estimated, yet it is obviously possible that errors of this kind might be cumulative, and that, on the one hand, an unduly small quantity of an attenuated culture, or, on the other hand, an unduly large quantity of a culture of 26,472-99. excessive virulence, might be prescribed. In view of these considerations, which do not appear to have been sufficiently appreciated by Mr. Haffkine, and, failing the production of experiments to show that no serious results need be anticipated from the inoculation of large doses, and that adequate protection is conferred by the inoculation even of small doses, we cannot but take a serious view of the fact that, in a case like the present where the estimation of the virulence was neglected, the weight of the bacterial sediment in a prescribed dose was in some samples of the vaccine seven times 26,272-6. as large as in other samples. The details of the experiments upon which this statement concerning the weights of sediment is based are to be found in Table III. in the evidence of Lieutenant Stewart Douglas, I.M.S. In view of the results of these weighings, and further, in view of the fact that no mere estimation of opacity would enable a judgment to be arrived at as to the quantity of dissolved toxins contained in a fluid, should any such be present, it seems to us that the routine method of standardizing the vaccine which was employed by Mr. Haffkine, must be pronounced to be imperfect. So imperfect is the method of standardization that we have no data for judging what the relation of strength is between doses of the samples we examined and the original dose which Mr. Haffkine has taken as his standard, nor are we able to form any estimate of the quantity of bacterial sediment which was contained in the original "standard dose." Assuming that the results obtained in our weighings represent the extreme limits of variation, the quantity of bacterial sediment employed may have consisted of any amount from 8 to 56 milligrammes.

II.(5.) *Character and Effects of the Liquid and Solid Elements of the Vaccine and Question of the Dose employed.*

422. It has been seen above that the volume of the vaccinating injection which is prescribed by Mr. Haffkine has varied between $2\frac{1}{2}$ and 20 c.c. Further, we have seen that the volume of the injection may have amounted, on the average, to something like $7\frac{1}{2}$ c.c. In view of the fact that considerable difficulty is experienced in the injection of such large quantities of vaccinating material, and, further, in view of the fact that the menstruum (which, since it contains peptone, is a toxic menstruum) bears here so large a proportion to the vaccinating substance proper, it becomes a matter of importance to consider in detail the composition of the vaccine.

(VII. and VIII.) Criticisms of composition of vaccine and of volume injected. Para. 405 of this Report.

Mr. Haffkine, in accepting these large quantities as necessary in cases where a scanty growth of plague has occurred in his nutrient medium, bases himself on three confessedly *à priori* and provisional assumptions. The first of these assumptions is, that the bacterial sediment protects the patient against being attacked by plague, while it does not in any way improve his chances of survival when he has been attacked. The second of these assumptions is, that the supernatant fluid of his anti-plague vaccine secures to the patient a greater chance of recovery when attacked. The third of these assumptions is, that the best composition of the vaccine is secured when the bacterial sediment and supernatant fluid are present in the vaccine, "in the proportion in which these elements are obtained in the process" of manufacture adopted by Mr. Haffkine. Mr. Haffkine adduces as a basis for these *à priori* assumptions the fact that the case mortality, *i.e.*, the percentage of deaths to attacks, has been reduced in the case of anti-plague inoculation, where the bacteria are injected in conjunction with the liquid menstruum in which they are grown, whereas the case mortality was not reduced in the case of the anti-cholera inoculations, in which the vaccine material consisted of cholera bacteria which were suspended in a merely watery menstruum. But, even if we assume the correctness of this particular statement, Mr. Haffkine's conclusion does not necessarily follow. For so numerous are the points of difference between cholera and plague that there can be no logical justification for asserting that a particular effect, which manifests itself in the case of one of these diseases, and not in the other, is an effect which is imputable to a particular modification of the vaccine which was employed.

Mr. Haffkine's theoretical assumptions regarding vaccine.

29.
App. LXXXII. in Vol. III. of these Proceedings.
26,504–8.
26,512–26.
31.

The utility or otherwise of each separate element in the plague vaccine is manifestly a matter which can only be determined by experiment. We may, therefore, set ourselves to inquire in the case of each element, first, whether any specific toxic effect, and, secondly, whether any protective effect, is produced by the introduction of that element into the system.

सत्यमेव जयते

423. We begin with the consideration of the deposit of plague bacteria which collects in the culture flasks.

Toxic effect of dead plague bacteria forming sediment of anti-plague vaccine.

It has been firmly established by numerous experiments in which dead bacterial cultures have been introduced into the organisms of animals—and in this connexion we may specially note the experiments which were done by the German Commission on monkeys—that the dead bodies of plague bacilli contain appreciable quantities of poisonous substances. Alterations in the blood, hæmorrhages in the gastric mucous membrane, and necrotic changes in the sub-cutaneous tissues at the site of the injection and in the liver, are the pathological effects which most often manifest themselves after the injection of plague bacilli.

Report of the German Plague Commission, p. 302.

424. It is not open to doubt that the introduction of the toxic elements, which are contained in the bodies of the plague bacilli, ultimately confers upon animals a certain power of resisting plague.

Protective effect of the sediment.

Yersin, Roux, and Borrel, in 1895, first brought forward evidence to show that a certain amount of protection could be conferred by inoculations of dead plague bacilli.

Annales de l'Institut Pasteur, 1895.

Further, we may note that this fact was confirmed by the experiments of Dr. Klein. We desire particularly to direct attention to the fact that a certain measure of protection was obtained in these experiments of Dr. Klein, for Mr. Haffkine has drawn from these experiments the conclusion that a protective measure may turn out to be effective in man, even when experiments on lower animals do not appear to contain "any elements justifying its application to men."

Local Government Board Report, 1896–7.
26,516.

The protective efficacy of injections of dead plague bacteria is further established by the many very careful experiments of the German Plague Commission. In particular, it was shown by the German Plague Commission that in the case of the

Report of the German Plague Commission, p. 302–20.

brown monkey (*macacus radiatus*), and in the case of the rat, a considerable measure of protection can be conferred by these inoculations. But the experiments of the German Commission also show that very slight, if any, protection is conferred by these inoculations on the grey sacred monkey (*semnopithecus entellus*).

The protective effect of inoculations of dead bacterial cultures was again confirmed by our own experiments. These were done on guinea-pigs, brown monkeys, and rats.

It is to be noted that in the many series of experiments which have been referred to above, there is hardly to be found an instance (unless possibly we have such an instance in the case of certain experiments on rats which were performed by Lieut. Walton, I.M.S.), where a very high degree of immunity has been obtained. In almost every instance, severe symptoms have supervened upon the subsequent test inoculation of living plague bacteria to which the vaccinated animal was subjected. What was achieved in the above experiments was, therefore, merely a modification of the plague attack, and a delayed or diminished mortality. These results (which, be it noted, were obtained by the injection of plague bacilli suspended in a merely watery medium), are in all respects identical with the results which have been obtained on man in cases where Mr. Haffkine's inoculation has not succeeded in averting an attack of plague. Thus the diminished case mortality which Mr. Haffkine imputes, in the case of man, to the effect of the supernatant fluid which forms a constituent of his anti-plague vaccine, is, in the case of animals, obtained in the absence of that supernatant fluid. 26,311.

Toxic effect of filtrate from plague cultures (supernatant fluid of anti-plague vaccine).

425. The question as to whether the supernatant fluid of Mr. Haffkine's prophylactic causes, when injected into the organism, the elaboration of substances which modify the severity of a plague attack, is a question which cannot be answered until we have determined whether a specific toxin is produced when the plague bacillus is cultivated in a fluid nutrient medium. It behoves us, therefore, first to consider this question.

Loc. cit. Yersin, Roux, and Borrel came to the conclusion that there was no specific toxin produced by the plague bacillus when it was cultivated in a liquid nutrient medium.

The German Plague Commission also investigated the question as to whether specific soluble plague toxins were developed when plague bacilli were cultivated in a liquid nutrient medium. In the first series of experimental injections which were made upon animals by the German Commission with a view of resolving this question, filtrates from 10-day old cultures of plague were employed. The experiments were performed upon rabbits and brown monkeys. In each case, 5 c.c. of the filtrate was injected. No toxic effect was observed to follow from these injections. No appreciable amount of soluble toxins was therefore produced in this instance. In a second series of experiments, the German Commission employed carbolized filtrates from sterilized six-week old cultures. The experiments were in this case done upon two rats. No control experiments were done with carbolized bouillon. The German Commission inferred, from the fact that both rats died, that a small quantity of toxins may possibly, after the expiration of six weeks, escape from the macerated bacterial bodies, and pass into solution in the nutrient fluid.

26,378, 25,384–5. Several additional series of experiments on this question were instituted by ourselves. The results of these experiments are incorporated in Tables I., II., and IV. of Lieut. Liston's evidence. In the first of these series of experiments the material which was employed was the (carbolized) filtrate from Mr. Haffkine's prophylactic. The animals, which received respectively 2 per cent. and 4 per cent. of their body weight of the supernatant fluid, succumbed to its effects. It is manifest that the carbolic acid in the supernatant fluid may be answerable for this result. In the case of the second series of experiments, (*i.e.*, of the experiments whose results are incorporated in Table II.), 26,384. the material which was employed consisted of the non-carbolized filtrate from Mr. Haffkine's prophylactic. In this case, with the exception of an animal which died from intercurrent disease, all the animals survived. A slight amount of necrotic change was observed to occur at the site of injection in the case of the animals which had been injected with doses of supernatant fluid amounting to 4 to 6 per cent. of their body weight. In view of the fact that these necrotic changes did not occur in the control animals injected with similar quantities of Mr. Haffkine's nutrient medium, it is manifest that a small amount of some specific toxin must here have been present in the filtrate from Mr. Haffkine's prophylactic. We are disposed to believe that this small amount of toxin may have been derived from the macerated bodies of the plague bacilli. The material which was employed in the third series of experiments consisted of a filtrate from a culture of virulent plague, which had been grown in ordinary peptone broth. The results of this series of experiments are incorporated 26,432.

in Table IV. of Lieutenant Liston's evidence. It was here established that when the plague bacillus is grown in an ordinary peptone broth toxins which are lethal to guinea pigs may, under certain conditions, be produced. In the experiments in question, the animals succumbed when the amount of the filtrate amounted to or exceeded 5 per cent. of their body weight.

No protective effect obtained from filtrates of plague cultures. Loc. cit.

426. The first experiments which were made to determine whether any protection was conferred by injections of filtrates from plague cultures were made in 1895 by Yersin, Calmette, and Borrel. These observers arrived at the conclusion that such injections conferred no protection.

Report of German Plague Commission, p. 355.

The German Plague Commission re-investigated this question. They experimented upon two monkeys. Each of these monkeys received a subcutaneous injection of 5 c.c. of the filtrate of a 10-day old bouillon culture. Both monkeys succumbed to a subsequent test inoculation of plague. In the case of one of the monkeys no protection, and, in the case of the other, only a very slight amount of protection would appear to have been conferred. This latter effect is explained by the German Commission by the assumption that the filtrate which was used in this case must have contained a certain quantity of substances which were derived from the macerated bodies of the plague bacilli.

Report of German Plague Commission, p. 320.

In addition to the experiments which have just been recorded, the German Commission made experiments on monkeys with the supernatant fluid, which was filtered off from a sample of Mr. Haffkine's prophylactic, and they compared the effects of the supernatant fluid with the effects of the bacterial sediment. The results of these experiments led the Commission to the conclusion that the whole protective power of Mr. Haffkine's vaccine was resident in the bacterial sediment, as distinguished from the supernatant fluid.

The above results are in absolute conformity with the results which were obtained by ourselves in two series of experiments.

In the series of experiments recorded in Table III. of Lieutenant Liston's evidence, it will be seen that the only guinea-pig which had survived the inoculation of the carbolized filtrate from Mr. Haffkine's prophylactic fluid succumbed with extreme rapidity when tested with a living culture of plague. This guinea-pig had obviously not acquired any power of resisting plague. 26,385.

The results of the second series of experiments are recorded in Table VI. of Lieutenant Liston's evidence. In this series of experiments the prophylactic power of the supernatant fluid of Mr. Haffkine's vaccine was compared with the prophylactic effect of a freshly-prepared sample of his nutrient medium. It was found that the average period of survival of (*a*) the three guinea-pigs who received only injections of the nutrient medium, and (*b*) of the three guinea-pigs who received comparable quantities of the filtrate from Mr. Haffkine's prophylactic fluid, was in each case 2⅓ days. It is manifest, therefore, that if there is any specific soluble plague toxin in the filtrate from Mr. Haffkine's prophylactic fluid—and we have seen that this is doubtful—this specific plague toxin must be a toxin which confers absolutely no protection against plague. 26,434.

Summary of criticisms on composition and volume of Mr. Haffkine's anti-plague vaccine.

427. The evidence which has been reviewed above appears to place beyond doubt the fact that the injection of the bacterial sediment does in the case of animals exercise an effect in the direction of the production of immunity. This immunity may be absolute where the test-quantum of plague culture which is introduced into the organism does not exceed a very small minimum. In such cases as this, the plague bacilli are destroyed before they can produce any noticeable symptoms. In other cases, what is achieved is merely a modification of the plague attack. This effect comes under observation wherever the test-quantum of plague culture which is introduced into the system is somewhat larger than the maximum quantity which the system is capable of effectually dealing with.

Further, the evidence which has been considered above indicates that the filtrate which is derived from the plague culture (the supernatant fluid of Mr. Haffkine's vaccine) does not lead to the elaboration of any substances which are capable of favourably modifying a plague attack. It neither confers upon animals any immunity against attack, nor does it, so far as can be seen, operate in the direction of reducing mortality. It would appear, therefore, that the supernatant fluid might with advantage be dispensed with, in the case of man, and it might readily be eliminated from the vaccine by a mere process of decantation. If it was so eliminated, several advantages would be gained. The task of inoculating would be rendered very much less laborious. The reduction of the volume of the vaccinating material would tend to diminish the dangers which might result from the possible contamination of the vaccine. By the elimination of the supernatant fluid there would be eliminated from the vaccinating material a considerable quantity of a poisonous substance (peptone)* which stands in no known relation to the production of immunity.

II.(6.) *Summary of Criticisms on mode of Preparation of Haffkine's Vaccine.*

General summary of criticisms on mode of preparation of Mr. Haffkine's vaccine.

428. While making the criticisms which we have been compelled to make above, on the methods which are employed by Mr. Haffkine, we have not lost sight of the fact that the only essential points in an anti-plague vaccine are, first, that it shall be capable of preventing and of favourably modifying attacks of plague; secondly, that it shall be capable of conferring an effect that will last some time; and thirdly, that it shall be capable of producing these good results without entailing any serious evil consequences.

Of subordinate importance to these are the questions, first, of the complete freedom from contaminations, and secondly, of the correct standardization of the vaccine. These have a practical importance only in so far as such defects may be the cause, on the one hand, of unnecessary suffering to the patient, and, on the other hand, of inadequate protection.

In other words, we recognise that even though a vaccine which is insufficiently standardized, and which is occasionally contaminated, is from the scientific point of view a very imperfect vaccine, yet judged from the standpoint of practical life, such defects may very well be overlooked if the insufficient standardization and the occasional contamination of the vaccine have not interfered in a sensible manner with its utility. This standpoint, which is indeed the only reasonable standpoint, is the standpoint which has been taken up by Mr. Haffkine in the statement that was handed in by him, and which is published, at his request, in our Proceedings.

App. LXXXIII. in Vol. III. of these Proceedings.

Innocuousness of contaminating micro-organisms present in anti-plague vaccine cannot be deduced from results of inoculation of small-pox vaccine.

Several of the statements which he makes in that memorandum do not, however, altogether commend themselves to us. We are of opinion, in the first place, that the importance of the presence of the contaminating micro-organisms in the anti-plague vaccine is not diminished by pointing out that such contaminations are present in the vaccine lymph which is employed in anti-small-pox inoculations. On the contrary, we think that the disadvantages which are associated with the presence of contaminating micro-organisms in small-pox lymph cannot be overlooked. Again, we are of opinion that while the bacterial contaminations of small-pox lymph cannot at present be entirely avoided, it would be possible in the case of a bacterial vaccine, such as the anti-plague vaccine, to take effective precautions against the presence of these contaminating micro-organisms. We consider this the more necessary, inasmuch as in the case of anti-plague vaccination considerable quantities of fluid are introduced sub-cutaneously, whereas in the case of small-pox contaminating micro-organisms are only placed on the surface of the skin. In view of this fact, we do not consider that Mr. Haffkine is justified in asserting that the contaminating micro-organisms which find their way into his vaccine are harmless, "as are harmless all those innumerable microbes that we eat and drink and breathe in our daily life, or as is harmless an apple, or an onion, or a mango, or any other living vegetable fruit that we eat uncooked." Manifestly we have here a comparison between things that are not in any respect comparable. The contaminating micro-organisms are, in one case, introduced into the alimentary canal, where they are innocuous, and, in the other case, into the sub-cutaneous tissues, where they may quite well be harmful.

App. LXXXIII. in Vol. III. of these Proceedings.

Such statements, however, apart, we find ourselves in agreement with Mr. Haffkine, that the good and the evil results of inoculation must be judged, not from experimental data obtained in the laboratory, but rather from the results which have been actually obtained in man.

III. Serious Ill-effects not produced in Man by Inoculation of Haffkine's Vaccine.

No serious ill effects have been produced by inoculation of Mr. Haffkine's prophylactic fluid.

429. We may dismiss in a few words the question of the evil effects which have resulted from Mr. Haffkine's inoculation. We have not had any evidence laid before us which goes to show that any serious ill consequences have resulted from the defect in sterility which was spoken of above. We made careful inquiries into this question in the various centres where anti-plague vaccinations have been performed. In the overwhelming majority of cases no evidence was adduced to show that any injurious effects had supervened upon inoculation. In a few isolated cases, however, there was evidence that abscesses had occurred in the vaccinated at the seat of injection. It is, of course, not certain that these abscesses were imputable to the condition of the

1753, 4743, 4781, 10,714, 11,705, 16,568.

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* We have not made any direct experiments on the toxic effect of peptone on man, nor do we know of any experiments made by Mr. Haffkine to determine whether any toxic effects result from the inoculation of his culture medium in man. But we conceive that it is hardly possible that a dose of 20 c.c. of a peptone solution, which may possibly contain from 3 to 6 per cent. of peptone, can be quite indifferent to the human organism.

vaccinating material. On the other hand, it must be noted that in many cases the long-continued reaction at the seat of inoculation and the continuance of the fever seemed to point to the presence of a certain amount of septic contamination. The German Commission also had this question under consideration. They state that they were not able to determine "whether the observed symptoms were in these cases purely toxic effects."

Report of the German Plague Commission, p. 320.

We have to consider, in connexion with this question of the possibility of evil results imputable to the anti-plague inoculation, a few cases in which death occurred suddenly in a few hours after inoculation in the case of persons who before inoculation appeared to be quite healthy. We have come to the conclusion that these cases are not to be imputed to any defect in the anti-plague vaccine. In addition to the fact that they have been quite isolated occurrences, there is the fact that no such cases of death have been reported to us as having occurred in two or more persons who were inoculated with the same vaccine. These cases of sudden death have always occurred at a time when plague cases were actually occurring, while they have not occurred in the absence of a plague epidemic. We are, therefore, of opinion that such sudden deaths are probably imputable to the fact of the inoculation having been made into a person who had already contracted the infection of plague.

2388, 4605, 4973.

Having said this, we may now pass from the consideration of these preliminary questions which relate to the composition and preparation of the vaccine to the consideration of the results which have been obtained in actual practice by its application.

IV. HISTORY OF FIRST SERIES OF INOCULATIONS WITH HAFFKINE'S VACCINE, WITH CRITICISM OF STATISTICS RELATING TO THE RESULTS, AND OF CONCLUSIONS DRAWN BY MR. HAFFKINE FROM THESE STATISTICS.

IV.(1.) *First Inoculations in Bombay.*

Effect of inoculation of prophylactic fluid on Mr. Haffkine. 32.

430. Mr. Haffkine first tried the physiological effect of the prophylactic fluid on himself. His description of the effect produced may here be introduced as representing the ordinary symptoms which follow inoculation. He says:—"The amount with which I was injected was 10 cubic centimetres, of which 6 c.c. were injected into my left flank, and four into my right. The symptoms, as far as they were perceptible, were as follows. Three or four hours after the injection my temperature began to rise, and reached the maximum 102½° F. in 8½ hours. From that time my temperature began to fall. At the seat of injection, almost parallel with the development of the fever, a tenderness began to develop, and reached its maximum next morning, which was about 15 hours after the time of injection. The region under my left arm, somewhat below the axilla, became tender on pressure, though, in my case, no glandular swelling formed. The seat of the inoculation reddened, and swelled and became so painful that I had great difficulty in getting up next morning. Still I was able to do so, and at no moment was I obliged to interrupt my work. I was inoculated on the 10th January (1897), and on the 11th an important meeting was to be held, presided over by the Director-General of the Indian Medical Service, Surgeon-General Cleghorn. I was able to take part in the meeting and until my symptoms had entirely disappeared, scarcely anyone knew that I had been inoculated, except the operator (Dr. Surveyor) and the Principal of the Grant Medical College, who had witnessed the operation. The fever disappeared between 20 and 24 hours after injection, when my temperature reached normal. The pain at the seat of inoculation, however, lasted for several—four or five—days and after the pain disappeared the nodule remained for a couple of weeks longer."

First inoculations in Bombay. 32.

431. After Mr. Haffkine had thus tested his fluid on himself he proceeded to inoculate volunteers from the general public of Bombay, with doses that he estimated to correspond with one quarter of that which had been used in his own case. He says:—"In the course of the first three weeks, from the 10th until the end of January (1897), several hundred persons of all ages and sexes offered themselves to be inoculated and the effects were carefully observed, on them. In no instance did we see anything which would point to a marked difference from the effect of the cholera inoculation, or which would indicate the possibility of evil consequences to the general health. This result impressed itself so much on the minds of those who underwent the inoculation or studied its effect on others that in the course of the next few months 8,142 people in Bombay came to avail themselves of the new treatment." Of these at least "356 belonged to the higher classes; 2,119 to the lowest; and the rest were between the two. The vast majority of these cases were persons who read newspapers, and who had physicians to consult. Under these conditions the fact of the 8,142 people escaping infection would probably have only a very relative bearing on the question as to the efficacy or otherwise of the

48–49.

inoculation if it had not happened that out of the 8,142 people 18 did get infected, all natives of India, chiefly of the class of servants, and went through the full course of the disease. Out of the 18 persons 16 recovered, and the two who succumbed had developed unmistakeable symptoms of plague within 24 hours of inoculation. From the history of these two cases it appeared probable, and in one case I know now for certain, that they had symptoms of plague on them already at the time of inoculation."

52. Mr. Haffkine says that it is almost certain that no fatal case, except the two mentioned, occurred among the inoculated, for "a large part of the persons inoculated in Bombay during the first part of 1897 were literate people who read books and newspapers, and were perfectly aware of the novelty of the treatment, whilst the vast majority of the rest were their servants." As, moreover, "the physicians in Bombay . . . kept a perfectly open mind with regard to the efficacy of the inoculation," and "exceedingly few expected any actual good from it . . . cases of plague, especially fatal cases, would not have escaped our attention or the attention of those who were observing the progress of this work." On the contrary, says Mr. Haffkine, "whatever seemed to be abnormal in the immediate effect produced by inoculation, even the most insignificant symptoms, were brought to our knowledge with detail and alarm. . . . However, it is obvious that in a large city like Bombay there was no possibility of our instigating a direct inquiry and following up every one of the 8,142 cases inoculated.

Inoculations at Mora.
52.

Mr. Haffkine, however, states that "somewhat more complete data were obtained with regard to a small group of people included in the above number of 8,142, but who lived half an hour from Bombay, across the harbour, namely, in Mora village. The population of Mora when the plague broke out was under 1,000, and out of this number 429 underwent inoculation; the rest remained uninoculated," the number of the uninoculated people being only approximate. Of the inoculated, seven were attacked with plague with no deaths, while among the uninoculated 26 cases with 24 deaths were reported. "I quote this instance," says Mr. Haffkine, "because it produced a great impression upon the inhabitants of Mora, and because its influence was reflected upon Bombay. But owing to the great pressure of work at the time, I could not follow up the cases in Mora to such an extent as to be able to guarantee that the figures are absolutely correct."

27,310–8. The attacks which took place appear to have all occurred before the beginning of February 1897. If, for the reasons given by Mr. Haffkine, we eliminate from consideration the two cases that proved fatal, the results with reference to the total number of persons inoculated, for a period which has not been specified, may from Mr. Haffkine's statement, be summarised as follows:—

Number of Persons Inoculated.	Attacks.		Deaths.	
	Number.	Per cent.	Number.	Per cent.
8,142	16	·2	0	0

The results for the group of inoculated persons, included among the above, who were resident in Mora, are, according to the evidence laid before us, as follows:—

——	Number.	Attacks.		Deaths.	
		Number.	Per cent.	Number.	Per cent.
Uninoculated - -	571 (?)	26	4·5	24	4·2
Inoculated - -	429	7	1·6	0	0

There are, however, no accurate data enabling us to form an opinion as to how many of the total of 8,142 inoculated actually escaped. Many of them belonged to the lowest classes, and it is by no means certain that deaths from plague among them would have been reported, especially as many may have left Bombay after the inoculation. Moreover, no death was reported among the 16 persons who were attacked, and such a reduction of case mortality has never been noticed elsewhere.

IV.(2.) *Inoculations in the Byculla House of Correction, Bombay.*

Her Majesty's House of Correction, Byculla.
34–49, 20,351–2.

432. An opportunity soon offered itself for testing the prophylactic fluid under conditions that permitted of strict observation of the results of inoculation. Plague broke out on the 23rd January 1897 in Her Majesty's House of Correction at Bombay,

and between the 23rd and the afternoon of the 30th of the month, when inoculations were resorted to, 14 cases of plague had been recognised, of which seven proved fatal. The official figures represent that of 338 prisoners present in the jail, 153 were inoculated and 185 were not inoculated. But from the detailed list of prisoners III. 445–56. supplied to us, on which these figures are obviously based, it would appear that from the number of 185 not inoculated, there ought for the purposes of our comparison to be subtracted the 14 persons who had been recognised as plague patients before inoculations commenced. Moreover, correspondence which we have had regarding the official figures, and which is published as App. No. LXXXVIII. in our Proceedings, has III. 658–61. shown that one prisoner enumerated in the Jail list as among the inoculated, was in reality not inoculated. The numbers of the non-inoculated and inoculated, after the necessary corrections, would stand respectively as 172 and 152. With these we may compare Mr. Haffkine's figures, first as given in evidence before us, and secondly as given in a communication addressed by him to the Royal Society, and published in the "British Medical Journal" of the 1st July 1899. Before us Mr. Haffkine said 34. the number of prisoners in the jail was 327, of whom 154 were inoculated. In his communication to the Royal Society he gave the total number of prisoners as 337, and the numbers of the inoculated and uninoculated respectively as 183 and 154. These discrepancies are of little importance. We have for convenience adopted the fuller statement that Mr. Haffkine made before the Royal Society to represent his figures.

The course of the plague in the jail up to the date when it ceased, and the occurrences of attacks and deaths among the inoculated and the uninoculated respectively, according to the corrected official figures, and also according to the figures laid by Mr. Haffkine before the Royal Society, are exhibited in the following table in parallel columns :—

—	Non-inoculated.				Inoculated.				Names and Official Numbers of Inoculated Prisoners who contracted Plague.
	M. Haffkine's figures.		Official figures.		M. Haffkine's figures.		Official figures.		
	Cases.	Fatal Cases.	Cases.	Fatal Cases.	Cases.	Fatal Cases.	Cases.	Fatal Cases.	
To January 30th, 1897, inclusive.	15	8	14	7	3	3	0	0	*a.* 672.—Keshav Umishankar. *b.* 832.—Rama Lakshman. *c.* 1,222.—Govind Pandu. *d.* 1,356 —Abdul Karim Golam Hussain. *e.* 1,336.—Ganput Babajee. *f.* 1,366.—Shamrao Sittaram.
Inoculations performed on January 30th, 1897.	M. Haffkine's figures show 183 prisoners not inoculated and 154 inoculated. The Official figures show 172 prisoners not inoculated and 152 inoculated.								
January 31st, 1897 - -	2	1	2	1	1	0	0	0	
February 1st „ - -	1	1	1	1	0	0	4 { *a.* *b.* *c.* *d.*	3 { *a.* *c.* *d.*	
„ 2nd „ - -	1	1	1	1	0	0	1 *e.*	0	
„ 3rd „ - -	0	0	0	0	0	0	0	0	
„ 4th „ - -	1	1	1	1	0	0	0	0	
„ 5th „ - -	2	1	2	1	0	0	0	0	
„ 6th „ - -	5	1	4	1	1	0	0	0	
„ 7th „ - -	0	0	1	0	0	0	1 *f.*	0	
Total January 31st to February 7th -	12	6	12	6	2	0	6	3	

On looking at this table, two discrepancies will be noticed which have a bearing on conclusions drawn regarding the relative immunity of the inoculated and the non-inoculated. One relates to the case of an inoculated prisoner, Ganput Babajee, who appears in the official statement as having been attacked with plague on the 2nd February. This man is omitted from Mr. Haffkine's statement, and the omission is III. 659 (*f*). explained on the ground that the diagnosis of plague was erroneous. But we have not excluded this man from our figures, as he was definitely held by the medical officers of the jail to have suffered from plague, and may, like two inoculated prisoners whose cases were brought to our notice in connexion with inoculations in the Umarkhadi 69, 7236 (I.) and (II.). jail at Bombay, have been suffering from a modified attack of the disease. The second discrepancy relates to three patients who are excluded from consideration by 34, III. 659 (*b*). Mr. Haffkine in calculating his results, on the ground that they had already contracted plague at the time when the inoculations were performed. If, however, cases are to be

47.

excluded for the reason that the full incubation period had not elapsed between the date of inoculation and the date of attack, we should, assuming that the incubation period may last as long as five days, omit not only the three prisoners omitted by Mr. Haffkine, but also every one who was attacked up to the 4th February. If this was done, and we think that it ought to be done, there would remain seven cases among the uninoculated, with two deaths, contrasted with one case, which recovered, among the inoculated. The comparison would thus be greatly in favour of the inoculated. The results, however, do not seem to justify the conclusion drawn from them by Mr. Haffkine that protection is acquired within 24 hours of inoculation, for during the first five days after the inoculations, there were five cases among the inoculated as compared with four among the prisoners who remained uninoculated.

IV.(3.) *Inoculations in Daman.*

Lower Daman.
52-60.
App. II. in Vol. I. of these Proceedings.

433. After the experiment in the Byculla House of Correction, inoculation was next tried at Daman, where plague had broken out in March 1897, as already stated in para. 45 of this Report. The circumstances connected with the inoculation operations at Daman were made the subject of a Special Joint Report by Mr. Haffkine and Major Lyons, I.M.S. The Report was based on inquiries made at Daman on the 20th and 21st of May, at which Drs. Koch and Gaffky, the heads of the German Plague Commission, assisted, and upon a house to house visitation carried out at the end of the month by Major Lyons. The results of the different series of inoculations that were done are separately grouped in the Joint Report, where the results that were obtained in the first three series are considered.

Normal population of Lower Daman.
I. 305.
27,214-29.
27,229.

Before entering into the results of the inoculations, we must consider what was actually the population of Lower Daman at the commencement of the period of observation. Mr. Haffkine and Major Lyons definitely state that the normal population of Daman Proper, Katheria, and Kariwari, which constitute the town of Lower Daman where the inoculations were performed, is 5,000, 4,700, and 1,200 respectively, amounting in all to 10,900. This statement was not based on a special census, but on information received from His Excellency the Governor that the population amounted to 11,000, and from a Parsee gentleman, who introduced inoculation into Daman, that the population amounted to 10,000. Major Lyons, under examination, admitted that the figures were arrived at "by a guess."

Population at time when inoculations instituted.
I. 305.
27,239-41.
I. 305-6.

From the normal population thus arrived at, the population actually present at the commencement of the inoculations was computed by making certain deductions. A deduction was made for the diminution of the population due to exodus. In the Joint Report it is estimated that 2,000 people had left the place before the 23rd March, 1897, but this figure, like that of the normal population, was a pure guess, apparently made by Mr. Judge, Assistant Collector of Salt Revenue. Another deduction was made for a decrease in the population on account of deaths from plague since the outbreak commenced. This again was made in a somewhat loose manner. It was based upon an estimate formed by His Excellency the Governor that the deaths in February might be neglected, and that the deaths in March might be assumed to amount on an average to 30 a day; but it is clear that there was no system of death registration which was at all trustworthy or capable of affording assistance in arriving at a correct estimate.

Results claimed from inoculation.
I. 308-9.

The inoculations which were performed in each of the three series, and the results which are claimed for them, may be tabulated as follows from particulars given in the Joint Report, viz. :—

FIRST SERIES.

Inoculations performed from the 23rd to the 26th March 1897.

Results claimed to have been obtained for the period from the 26th March to the 23rd April :—

Number.			Cases.	Deaths.	Total Plague Mortality.	Case Mortality.
					p. c.	p. c.
Inoculated -	Dr. Kalapesi	846	17	3	·4	17·6
	Dr. Poiares	171	6	3	1·8	50
Total -		1,017	23	6	·5	26
Uninoculated -		7,213	—	716	9·9	—

SECOND SERIES.

Further inoculations performed from the 17th April to the 2nd May 1897.

Results claimed for the period from the 2nd May to the 19th May.—

—	Surviving from First Series.	Inoculated in Second Series.	Total.	Cases.	Deaths.	Total Plague Mortality.	Case Mortality.
Inoculated Dr. Kalapesi -	843	529	1,372	52	18	p.c. 1·3	p.c. 34·6
Inoculated Dr. Poiares -	168	99	267	12	9	3·3	75·0
Total - -			1,639	64	27	1·6	42·0
Uninoculated - -			5,869	—	674	11·5	—

THIRD SERIES.

Further inoculations performed from the 21st to the 23rd May 1897.

Results claimed for the period from the 23rd May to the end of May:—

—	Surviving from First and Second Series.	Inoculated in Third Series.	Total.	Cases.	Deaths.	Total Plague Mortality.	Case Mortality.
Inoculated, Dr. Kalapesi and Dr. Da Cunha.	1,354	552	1,906	1	1	p.c. ·05	p.c. 100
Inoculated, Dr. Poiares	258	0	258		2	·8	66
Total - -			2,164	4	3	·1	75
Uninoculated - -			4,643	—	93	2	—

Mr. Haffkine and Major Lyons sum up the results as follows:—"During the three periods of observations put together, between the 26th March and the end of May, 6,033 uninoculated had 1,482 deaths (24·6 per cent.), while 2,197 inoculated had 36 deaths (1·6 per cent.). . . . This represents a difference in mortality of 89·2 per cent." I. 308.

Criticism of figures tabulated above.

It is to be noted that between the dates when the first period of observation closed and the second period opened there is a gap of eight days, while there is a similar gap of three days between the second and third periods of observation. But a scrutiny of the statements shows that the figures of the population—and this is particularly important in connexion with the uninoculated part of the population—at the opening of the second and third periods of observation respectively, can be arrived at from the figures of the preceding period by a simple subtraction of the deaths put down for that period, and by a transference of the number of newly inoculated persons from the category of the uninoculated to that of the inoculated. It is obvious that Mr. Haffkine and Major Lyons have altogether omitted to take into account the deaths which must have taken place in the gaps which we have noticed. We have no means of telling exactly how many deaths have thus been left out of account, but we may remark that there is a table in the Joint Report itself from (I. 306.) which we have ascertained that 327 deaths are recorded as having occurred between the 25th April and the 2nd May. Further, we have not been informed how the inoculated who were operated upon between the 17th April and the 23rd April inclusive were brought to account in case any plague occurred among them. Moreover the number of inoculated persons with which the third period of observation opens includes 54 persons who had been attacked by plague during the two preceding periods, and were, for the most part, probably convalescent. These persons ought after their attack to have been excluded from further consideration. A similar deduction ought to have been made for the number of the uninoculated persons who had been attacked. As the number of attacks among the uninoculated is not given, we have, taking as our guide the case mortality given for the uninoculated in the Daman investigation sheets, presently to be referred to, estimated that the number of uninoculated persons who had been attacked in the first two periods of observation must have been about 417. Lastly it is important to notice that the method of computation adopted in the Joint Report admits of another serious cause of error, inasmuch as it makes no allowance for diminution of population by exodus.

Method of obtaining cognisance of deaths at Daman.

The next point to consider is whether the data concerning attacks and deaths incorporated in the Joint Report are themselves accurate. Up to the 25th April, which covers the first period of observation, the daily mortality "was recorded officially by information from the inhabitants coming to the registration office to declare cases of deaths in their families." I. 305. To show how inaccurate the official registration of deaths was at that time, it may be stated that "on the 25th April the Governor placed a guard of his own on the burial and burning grounds, and on that day, though the number of deaths reported by the inhabitants was 11, the number of bodies disposed of in the presence of the guard was 34." It is evident that during the first period of observation the number of deaths as registered by the authorities is quite inaccurate. From the 25th April an official guard was kept permanently on the burial and burning grounds by His Excellency the Governor. From this date onwards the official information available regarding the number of bodies disposed of is, we may presume, more accurate. But the official measures provided no means for ascertaining the occurrence of plague till after death, I. 306. and in view of the fact that inoculation was not introduced on the initiative of the Portuguese Government, no official steps appear to have been taken to ascertain whether any of the dead had been inoculated.

Mr. Damaun Valla's statistics.

The official information regarding the mortality and attacks in Daman is, however, supplemented by the inquiries instituted and carried on by a Parsee gentleman, Mr. Seth Sorabji Damaun Valla, who was particularly interested in the inoculations. We must pay particular attention to the investigations of Mr. Seth Sorabji Damaun Valla, for the Daman figures appear to be almost entirely dependent on his statistics, or rather on the figures gathered by his peons and servants. He states 25,427. that he kept a watch over the people inoculated in Daman by employing about half-a-dozen agents who knew all the people. Whenever people were inoculated, his servants inquired every day to ascertain how they were getting on. Those who were inoculated also had instructions to let him know if there was any sickness among them. Then he had his sepoys and servants at the burial and burning grounds at the 25,430. beginning of plague, and they brought information if his other people failed to give it. They inquired whether bodies brought for disposal were inoculated, and ascertained the name, and reference was afterwards made to the inoculation registers. Asked how he was satisfied that the answers they gave him were true answers, he stated that: 25,432-3. "Because whenever they were ill I used to know it, and gave them medicine as I gave to others also. Generally people came to me running whenever they got ill and my men always used to go and inquire who was ill amongst the inoculated people." We can hardly believe that the information thus obtained can be accurate, and, in support of this opinion it will only be necessary to quote an answer given by Mr. Seth Sorabji Damaun Valla to a question, as follows:—

25,446. *Q.* "Amongst the 2,200 people inoculated in the first season have there been, up to date, any deaths from causes other than plague"?

A. "Amongst the inoculated I have not found a death from any cause other than plague."

We are not disposed to admit that a population of 2,200 people had no death among them for two years. But it should be noted here that the authors of the Joint Report in referring to the statistics collected by Mr. Seth Sorabji Damaun Valla state that I. 306. "these details were found afterwards, in the course of a close investigation by us, to be scrupulously correct." I. 306. Mr. Haffkine states that "considering the small extent of the town, the limited number of inhabitants, and the number of medical officers who were looking after the place, it appeared probable that not many attacks among the inoculated escaped their notice, as such attacks usually excite much comment among these inhabitants, and attract general attention. Indeed, the gentlemen present at the meeting (on May 20th) seemed to know between them every place in the town where inoculated people lived, and every house which had suffered from plague or happened to escape. As has already been mentioned, they stated at the time that there was a small number of inoculated attacked whom they did not see, but of whom, they informed us a record existed in the office of Seth Sorabji Damaun Valla. . . . . He had a personal knowledge of the people who were inoculated, and kept a watch over the effect of the operation, collecting with the help of his office establishment a large number of details in this connection." Mr. John Moniz, a medical officer, who was in the Portuguese Government service during the year 1897, and is one of those referred to in the Joint Report, in answer to the question, whether it was possible to find out regarding each dead body whether the person had in life been inoculated or not, stated that: "In the year 1897, there was so much confusion and panic that it was impossible to take down these particulars." We can hardly doubt that this statement of Mr. Moniz correctly represents the state of affairs, if we note the extreme virulence of the plague in Lower Daman. In a population estimated to number ordinarily about 11,000 or 12,000, the official figures, defective as they may be, record a total of 2,189 plague deaths from the time of the outbreak in February to the close of the period of observation in May, and a house to house inquiry made by Mr. Seth Sorabji Damaun Valla resulted in the confirmation of 2,093 deaths up to the 19th May 1897.

16,667.

I. 306.

Conclusions of the German Plague Commission regarding Daman.

Report of the German Plague Commission, p. 333.

We may note that Professors Koch and Gaffky have expressed their opinion that "the material which was collected left much to be desired from the point of view of completeness and trustworthiness, as indeed could only have been expected." "Still," they say, "an impression which may, probably, be taken to be approximately correct, was obtained" by them regarding the results of inoculation at Daman. This impression appears to have been strengthened by the results of Major Lyons' enquiries which are incorporated in the Joint Report. The German Plague Commission have generally adopted the statistics set forth in the Joint Report.

Conclusions regarding statistics for Daman as a whole.

Our own conclusions as regards the general effects of inoculation in Daman may be stated as follows. Considering (1) that the estimate of the population of Daman, on which statistics regarding plague incidence in the town are based, is only approximate; (2) that the total number of inoculated and non-inoculated people who left Daman is unknown; (3) that the total mortality in Daman for the period of observation, and particularly up to April 25th, that is during the height of the epidemic, is unknown; (4) that the proportion of deaths reported to have occurred among inoculated and non-inoculated respectively, at Daman, is based almost, if not entirely, on the reports of the peons, sepoys, and servants of Mr. Seth Sorabji Damaun Valla; and (5) that there are serious errors in the methods by which results have been calculated in the Joint Report; we are of opinion that no exact conclusions can be drawn from the data at our command which relate to the town as a whole. Nevertheless, while unable to accept the statistics as accurate, we attach some importance to the fact that Mr. Damaun Valla and the medical men who observed the effects of inoculation during the outbreak were satisfied that it exerted a great protective influence.

Inoculation among Parsees at Daman.

I. 306–7.

Having now discussed the figures for the town as a whole, we may consider what conclusions can be drawn from particular series of figures obtained from a narrower field of observation. The first series of data which we may consider in this connexion relates to the Parsee community of Daman. The results as collected by Mr. Seth Sorabji Damaun Valla with reference to 306 members of the community are as follows:—

—	Number under observation.	Cases.	Deaths.
Non-inoculated	29	—	4
Inoculated	277	8	1 (probably infected before inoculation).

These results are very favourable to inoculation, but in the absence of other details are not sufficient to form a basis for a conclusion.

Daman investigation sheets.

I. 307.
16,862–77,
27,210–3,
27,284–6,
27,297, 27,301.

Another series of data is that contained in the record of Major Lyons' house to house investigations. This officer went to Lower Daman on the 26th May 1897, the object of his visit being to find out accurately by minute inquiry in each house the results of the anti-plague inoculations which had been done. For this purpose he divided the town into four sections, and during four days, between the 26th and 30th May 1897, visited all the houses section by section, and he made inquiries at every house inhabited by inoculated persons which was pointed out to him as one in which a plague case had occurred. In each case he obtained information at the house visited from some one inmate who was "fairly intelligent." As a number of the dwellings had been evacuated and the inhabitants were encamped in the fields outside the town, Dr. Lyons visited them in their encampments and collected information from them, in the same way as he collected information from the houses.

I. 310-30. The total results of the inoculations which we have summarised from Major Lyons' investigation sheets regarding 89 houses are as follows:—

—	Number.	Attacks.		Deaths.		Case mortality Per cent.
		Number.	Per cent.	Number.	Per cent.	
Uninoculated - -	123	55	44·7	38	30·9	69
Inoculated - -	382	91	23·8	36	9·4	39·6
Diminution of mortality in favour of the inoculated - - -					21·5	

Out of the 89 houses to which these figures refer, in 62 houses both inoculated and non-inoculated were present, and in 20 of these the inoculated alone were attacked, while in 22 the non-inoculated alone suffered. In 20 houses both inoculated and non-inoculated were attacked.

In these 62 houses, in which uninoculated controls were present, the results obtained are as follows:—

—	Number.	Attacks.		Deaths.		Case Mortality Per cent.
		Number.	Per cent.	Number.	Per cent.	
Uninoculated -	123	55	44·7	38	30·9	69
Inoculated - -	255	50	19·6	20	7·8	40
Diminution of mortality in favour of the inoculated - - -					23·1	

The results thus are very favourable to inoculation. It is, however, to be remarked that of the people whose names appear in these investigation sheets none were inoculated till the last week of March, and more than half were not inoculated till the climax of the epidemic had passed. The effects of the inoculations are thus exaggerated, inasmuch as the period of exposure to infection was in the case of the uninoculated greater than in the case of the inoculated.

Comparison between results in investigation sheets and in Daman.
I. 308.

The total mortality from plague among the uninoculated in the houses where both inoculated and non-inoculated persons lived was only 1¼ times larger than the mortality, 24·6, which, according to the Joint Report, is the mortality among the uninoculated in the rest of the town, whereas the mortality among the inoculated people in these houses was about 5 times as great as the mortality, 1·6, which is the figure given in the Joint Report as that of the mortality among the inoculated in the whole of the town. This result may in part be imputable to the under-estimation of the mortality among the inoculated in the town. With reference to houses in which more than one case occurred, we think that the comparatively large proportion of the inoculated residents who were attacked is capable of explanation on the assumption that inoculation is not nearly so protective to persons who are brought into close and continuous contact with infection in their own houses as it is to those who run merely the risk of infection that is incident to living in a plague infected town.

Further results at Daman.
25,441.

To complete the history of inoculation in Daman, it may be added that, according to Mr. Seth Sorabji Damaun Valla, of the 2,200 people inoculated at Daman during the first season, 46 died of plague in the first season (1897), 19 in the second season (1898), and two in the third season (1899). Of the 1,115 people inoculated in 1898 at Daman, and of the 200 people inoculated during the same season at Katheria, 12 died of plague in 1898 and four in 1899. Of the 397 people inoculated in 1899 no one had died of plague up to March 15th, 1899.

IV.(4.) *Inoculations in Lanauli.*

Inoculations in Lanauli. 60-1, 26,535.

434. The next series of inoculations were performed at Lanauli, a hill station within four hours of Bombay on the way to Poona. Mr. Haffkine and his assistants proceeded to Lanauli in July, 1897, about a month after plague had broken out again after a temporary subsidence. The total population was then below 2,000, and consisted "largely of railway officers who lived in separate quarters away from the rest of the population. Their quarters remained almost entirely free from plague, and there were only two wards in the town which got the plague badly. . . . . The whole town was divided into four wards, and . . . . the officers of my laboratory," says Mr. Haffkine, "took over the two severely affected wards. We began first of all by taking a detailed census of the population, and I have the investigation sheets referring to each family separately, and giving the ages and sexes and names and other details of the members of every household." 60.

The following table has been put before us by Mr. Haffkine to show the results obtained at Lanauli:—

OCCURRENCES of PLAGUE in C. and D. WARDS of LANAULI (put together), between the 24th July, 1897, and the end of September, 1897. III., 352.

Date.	Number of uninoculated present.	Attacks.	Deaths.	Number of inoculated present.	Attacks.	Deaths.
24.7.97 -	711	4	4	45	—	—
25.7.97 -	636	5	5	116	—	—
26.7.97 -	621	4	3	126	—	—
27.7.97 -	568	2	2	175	—	—
28.7.97 -	544	3	3	197	—	—
29.7.97 -	472	2	1	266	—	—
30.7.97 -	460	6	4	276	—	—
31.7.97 -	430	3	2	300	1	1
1.8.97 -	398	8	6	328	3	2
2.8.97 -	373	8	6	342	3	1
3.8.97 -	341	1	1	363	1	—
4.8.97 -	336	3	2	336	1	—
5.8.97 -	331	1	—	368	1	—
6.8.97 -	329	3	1	367	—	—
8.8.97 -	323	1	—	370	—	—
9.8.97 -	322	1	1	370	—	—
10.8.97 -	320	1	—	371	1	—
11.8.97 -	319	1	1	370	—	—
12.8.97 -	318	1	—	370	1	1
13.8.97 -	316	1	1	370	—	—
14.8.97 -	315	1	—	370	—	—
17.8.97 -	314	1	—	370	—	—
19.8.97 -	313	1	1	370	1	1
20.8.97 -	312	1	—	369	—	—
22.8.97 -	311	6	5	369	—	—
23.8.97 -	305	—	—	369	1	1
26.8.97 -	305	1	1	368	—	—
3.9.97 -	304	1	1	368	—	—
4.9.97 -	303	1	—	368	—	—
6.9.97 -	302	1	1	368	—	—
7.9.97 -	301	3	3	368	—	—
13.9.97 -	298	1	1	368	—	—
23.9.97 -	297	1	1	368	—	—
Total -	—	78	57	—	14	7
Average daily strength -	377	—	—	323	—	—

From these figures the results deduced by Mr. Haffkine are as follows:— 61.

—	Average Daily Strength.	Cases.		Deaths.		Case Mortality Per cent.
		Number.	Per cent.	Number.	Per cent.	
Uninoculated -	377	78	20	57	15	73
Inoculated - -	323	14	4	7	2	50

Conditions under which average strength may be used as a basis for calculating effects of inoculation.

The method of calculating results which is here adopted by Mr. Haffkine differs from the method which was applied in the case of the inoculations done in the Byculla Jail and at Daman. There the inoculations were all completed before the period of observation began, and the incidence of plague could be calculated on the absolute strengths of the inoculated and uninoculated groups. Here, on the contrary, the inoculations were continued into the period of observation, and there was consequently a transference during that period of uninoculated persons to the inoculated group; therefore, the incidence of plague must, at least for the period during which the inoculations were continued, be calculated, not on the absolute strengths, but on the average numbers of inoculated and uninoculated persons present. Inasmuch as very considerable complication is introduced when the incidence of plague has to be calculated on the average instead of upon the absolute strengths, it will be convenient here, before considering Mr. Haffkine's calculations, to discuss the conditions under which calculations of this kind will afford accurate indications of the amount of protection conferred by an inoculation. The first point to note in this connexion is that it is essential for the criticism of any calculation which is based on average strengths to have before us in the form of a statement, such as that given above, the numbers of inoculated and uninoculated persons actually ascertained to be present by a series of periodical enumerations, and the numbers of the plague occurrences among them in the intervals between the successive enumerations. In the event of the inoculations having been commenced after the advent of plague, it is desirable to have the figures from the commencement of inoculation down to the end of the outbreak. Having from such a statement deduced the average number of inoculated persons present during the period of observation, the date should be ascertained at which the number of inoculated persons found present approximates most closely to their average strength. This date may be taken as dividing the epidemic into two phases. Throughout the phase preceding this date the inoculated are less in number than their average strength, while throughout the phase which supervenes upon this date their number would be more than the average strength. The direct contrary of this would hold, of course, of the uninoculated. This point having been clearly appreciated, it will appear, on consideration, that the incidence of plague upon the average strengths of the two groups will accurately represent the relative susceptibility of the two groups only when, on the one hand, the excess of the uninoculated in the first phase is accurately balanced by the excess of the inoculated in the second phase of the period of observation, and when, on the other hand, the severity of the plague in the earlier phase is neither greater nor less than the severity of the plague in the later phase. We may note in passing, first, that we may gauge the relative severity of the epidemic by calculating the percentage incidence of plague upon the average strength of the uninoculated for each separate phase, and secondly, that a longer period of less severe plague may be taken as counterbalancing a shorter period of severer plague. Only when the conditions referred to above are complied with will there be a guarantee that the excess of the uninoculated during the earlier phase of the epidemic were exposed to a risk of infection which was neither greater nor less than that which was incurred by the excess of the inoculated in the second phase of the period of observation. On the contrary, when the two phases of the epidemic do not counterbalance each other in the matter of severity, the incidence of plague on the two groups will fail to represent correctly their relative susceptibility to plague infection. Where, on the one hand, the plague was severer in the first phase, the comparison would, owing to the greater exposure to infection of the uninoculated, be unduly to the advantage of inoculation. Where, on the other hand, the plague was severer in the second phase, the comparison would, owing to the greater exposure to infection of the inoculated, be unduly to the disadvantage of inoculation. It will therefore be necessary to apply a correction in cases where, owing to the unequal severity of plague in the two phases of the epidemic, a consideration of the incidence of plague on the two groups does not give accurate results. This correction can be applied by striking off one or more rows of figures from the tabular statement which supplies the figures for the calculation. By striking off figures from the top or the bottom of the list of figures we plainly, in the one case, increase and, in the other case, reduce, the average strength of the inoculated, so that the opening day of the second phase of the period of observation will fall upon a later or, as the case may be, an earlier date than that upon which it falls when the average strength has been worked out upon the entire series of figures. By an adjustment of this kind it will be possible to divide up the period of the epidemic into two phases of more equal severity. It is obvious that this process of correction is anything but a simple one. For, in striking off one or more rows from the table, there will be struck off along with the figures which represent the number of inoculated and uninoculated persons, also the corresponding figures for plague attacks and deaths. Inasmuch as the estimate of the severity of plague, in the particular phase to which the eliminated figures refer, will have been based in part upon those figures, it may be necessary to compensate for this by a secondary correction. It will, in short, be necessary to resort to a system of "trial and error" to determine what period of observation will yield an average strength, such that the two phases of the epidemic which are, as we have seen, disposed on either side of the date on which the inoculated attained the average strength upon which the incidence is calculated, may be as long as possible, and may, as nearly as possible, represent periods of equal exposure to infection.

Consideration of results at Lanauli.

In accordance with the principles above laid down, we may, in connexion with Mr. Haffkine's tabular statement regarding Lanauli, first consider the question of the necessity of resorting to a calculation on average strengths. A consideration of the table will show that, owing to the practical completion of inoculations on that date, a calculation on absolute strengths would be applicable from the 5th of August onwards to the end of the epidemic. If this had been applied the incidence of plague in the inoculated and the uninoculated groups would have worked out as follows:—

—	Number.	Attacks.		Deaths.		Case Mortality. Per cent.
		Number.	Per cent.	Number.	Per cent.	
Uninoculated - -	330	29	8·8	18	5·4	62
Inoculated - -	370	5	1·3	3	·8	60
Diminution of mortality in favour of the inoculated - - - - -					4·6	—

Mr. Haffkine has instead resorted to a calculation on average strengths, and we may now examine his calculations with a view to see how far they conform with the principles enunciated above. Inspection of the tabular statement will show that the number of the inoculated reached the average strength, 323, on which Mr. Haffkine calculates the incidence of plague, on the 1st of August. Consequently this date marks the point at which the period of observation is divided into its two phases. In the first of these phases—the phase throughout which the inoculated were below their average strength—the severity of the epidemic is measured by the fact that of the average strength of the uninoculated during that phase 5·2 per cent. were attacked. In the second phase—in which the inoculated were throughout in excess of their average strength—the severity of the epidemic is measured by the fact that 15·8 per cent. of the average number of the uninoculated present during that phase were attacked. In view of this, it will be seen that the comparison which Mr. Haffkine has made is unduly to the disadvantage of inoculation. We may, however, note that the comparison is not as inequitable as might have been expected from the inequality in the severity of the plague in the two phases of the period of observation. This is probably due to the fact that, very early in the second phase, the number of the inoculated reached its maximum, and that during the long period which intervened between the attainment of this maximum and the end of the epidemic, the numbers of the inoculated and of the uninoculated did not differ very materially from the average numbers taken over the whole period of observation. That this is the real explanation of the fact that Mr. Haffkine's calculation is not more inequitable to inoculation will be obvious if we consider what his results would have been if he had taken only the period before the 5th of August. A calculation on average strengths from the figures up to this date would give the following results:—

—	Number.	Attacks.		Deaths.	
		Number.	Per cent.	Number.	Per cent.
Uninoculated - -	491	49	10	39	7·9
Inoculated - -	239	9	3·7	4	1·7

Results more unfavourable to inoculation would thus be obtained, and this is in accordance with the fact that the excess of the inoculated over their average strength in the severer phase of the period of observation which ends on the 4th of August, is relatively greater than their excess over their average strength in the severer phase of the longer period of observation which was taken into consideration in Mr. Haffkine's calculation.

We may now pass on to consider the more important question of the trustworthiness of the data on which the above calculations are based, and the method which was employed for determining the numbers of inoculated and uninoculated present in Lanauli on each day during the period of observation. A scrutiny of the figures representing the numbers of the inoculated and uninoculated present on the successive days in Mr. Haffkine's table given above shows that they cannot have been based upon a daily census. The figures given for each day can be computed, in every case but two, from those of the preceding day by the method of computation which we have already noticed as that by which the numbers of the inoculated and uninoculated in each of the three series of inoculations in Daman were computed from the preceding series. In one of the cases where this is not so—on the Para. 433 of this Report.

4th August—the discrepancy is probably due to a clerical error; in the other case—on the 5th August—there is a difference of one, and it is to be noticed that this same difference of one re-appears in a comparison of the opening and final figures of the statement. The number of the inoculated and uninoculated present on the last day of observation, added to the figures showing the total number of persons attacked during the outbreak, is one more than the figures showing the population on the first day of observation, two months before. It is, therefore, apparent that Mr. Haffkine's figures do not allow for any exodus of the population. But Mr. Haffkine admits that he had
160. ascertained that "a certain number of inoculated and uninoculated" did leave the town during the period of observation, as they did also in the case of Kirki, which will next be considered. In view of this we cannot accept as accurate the figures laid before
60. us, which have been based on computations and not on the "investigation sheets referring to each family separately" which Mr. Haffkine has in his possession.

Apart, from Mr. Haffkine's figures, we have had evidence with regard to the effect of the inoculations in Lanauli, laid before us by Major Richard Baker, I.M.S.,
18,430. who stated that he noticed that at Lanauli "in the place where inoculation had been made use of, the town was thriving and full of people," and the other part of the town
18,431. was absolutely empty. . . . . One side had plague and the other had none."

So far as we are able to judge, therefore, on a review of all the evidence laid before us, we arrive at the conclusion that inoculation exerted a distinct preventive effect for the short time during which the epidemic lasted at Lanauli.

IV.(5.) *Inoculations in Kirki.*

Inoculations at Kirki.

435. After the outbreak at Lanauli, the inoculations were tested at Kirki, a cantonment adjoining Poona. Mr. Haffkine states that "the group of people who
68. were inoculated were the native followers of the four batteries of artillery stationed there. The total number of followers, including males, females, and children at the time of the epidemic was above 1,500. They lived in 27 Government barracks on an isolated maidan, or lawn, more or less away from the rest of the population, and were subject to a strict supervision, during the whole time of the epidemic, on the part of all the military authorities and of a special medical staff. The inoculated and uninoculated belonged to an absolutely uniform class of the population. A large number of those inoculated were members of the same families as the uninoculated."

21,229-35. 21,975-21,981. When at Poona we endeavoured to obtain further information with regard to the inoculations at Kirki from Colonel Fawcett, R.A.M.C., the Principal Medical Officer at Poona. This witness, however, stated that, owing to various reasons, the Medical Officer in charge at Kirki at the time had been unable to keep a proper record of the inoculations, so that he was not in a position to bring forward any facts.
26,351-5. Mr. Haffkine, however, was himself on the spot, and personally with two assistants collected the information he has supplied to us. He was in Kirki, he says, "during nearly the whole of the epidemic, and was visiting the infected barracks and the Plague Hospital twice a day." The following are the statistics regarding Kirki, as tabulated by Mr. Haffkine:—

III. 352. Occurrences of Plague in the Followers of the Four Batteries at Kirki (put together), between the 16th August, 1897, and the end of September, 1897.

Date.	Number of uninoculated present.	Attacks.	Deaths.	Number of inoculated present.	Attacks.	Deaths.
16-17.8.97	1,542	11	10	98	—	—
17-18.8.97	1,307	4	4	322	—	—
18-19.8.97	1,268	2	1	357	1	1
19-20.8.97	1,239	6	4	383	—	—
20-21.8.97	1,105	7	7	511	1	1
21-22.8.97	1,074	5	5	534	2	—
22-23 8.97	1,047	3	3	554	2	1
23-24.8.97	1,044	9	7	552	5	3
24-25.8.97	926	6	4	656	—	—
25-26.8.97	827	6	6	749	3	2
26-27.8.97	812	3	1	755	4	3
27-28.8.97	809	5	3	751	2	1
28-29.8.97	804	4	2	749	—	—
29-30.8.97	800	3	3	749	1	1
30-31.8.97	797	2	1	748	1	1
31.8.1,9.97	795	11	6	747	1	1
1 2.9.97	784	9	4	746	1	1
2-3.9.97	775	3	2	745	1	—
3-4.9.97	772	3	2	744	—	—
4-5.9.97	769	5	3	744	1	—
5-6.9.97	764	6	3	743	2	—
6-7.9 97	758	3	3	741	—	—
7-8.9.97	755	1	—	741	1	—
8-9.9.97	754	4	2	740	—	—
9-10.9.97	750	1	1	740	—	—
10-11.9.97	749	1	—	740	1	—
11-12.9.97	748	3	2	739	—	—
12-13.9.97	745	1	1	739	—	—
13-14.9.97	744	4	3	739	1	1
14-15.9.97	740	1	—	738	—	—
15-16.9.97	739	2	—	738	—	—
16-17.9.97	737	2	2	738	—	—
17-18.9.97	735	1	1	738	—	—
19-20.9.97	734	1	—	738	1	—
20-21.9.97	733	2	—	737	—	—
23-24.9.97	731	1	1	737	—	—
25-26.9.97	730	1	1	737	—	—
28-29.9.97	729	1	—	737	—	—
Total	—	143	98	—	32	17
Average daily strength	859	—	—	671	—	—

Consideration of results at Kirki.

A consideration of this table shows that in Kirki, as in Lanauli, for the greater part of the time during which the epidemic lasted after the introduction of inoculation, the value of inoculation can be calculated on absolute strengths. From the 26th of August to the end of the epidemic there were no fresh inoculations, and for this period there is no necessity to resort to a calculation on average strengths. For this period a calculation on absolute strengths gives the following results:

——	Number.	Attacks.		Deaths.		Case Mortality Per cent.
		Number.	Per cent.	Number.	Per cent.	
Uninoculated -	812	84	10·3	47	5·8	56
Inoculated - -	755	18	2·4	9	1·2	50
Diminution of mortality in favour of the inoculated - -					4·6	

Mr. Haffkine, however, has calculated the number of attacks and deaths upon the average daily strength in order to compare the susceptibility to plague of the inoculated and the non-inoculated The daily strength of the inoculated reached its average on the 24th August 1897. Before this date the number of attacks among the uninoculated amounted to 4·9 of their average strength for that period, while in the subsequent phase of the epidemic, 11·8 per cent. among them were attacked. In these circumstances, after taking into account the fact that the maximum number of the inoculated was reached soon after the beginning of the second phase, we might have expected that Mr. Haffkine's calculation would have slightly underestimated the effects of inoculation, inasmuch as the phase of the outbreak during which the inoculated exceeded their average strength was severer than the preceding phase. His calculation is as follows:—

68.

	Average daily Strength.	Attacks.		Deaths.		Case Mortality Per cent.
		Number.	Percentage.	Number.	Percentage.	
Uninoculated -	859	143	16·6	98	11·4	67·8
Inoculated - -	671	32	4·7	17	2·5	53

It will be seen that this calculation gives a slightly lower value for inoculation than that obtained by the calculation on absolute strengths. The result is as close an approximation as can be expected in applying the complicated method of calculating on averages to figures of an individual epidemic which are to a large extent the result of undetermined causes.

With regard to the trustworthiness of the data which are here in question, it is to be remarked that the figures in Mr. Haffkine's statistics, representing the numbers of the inoculated and the uninoculated, are arrived at by a method of computation similar to that which we have already noticed in the case of Daman and Lanauli. The errors which we have pointed out in the case of the Daman and Lanauli statistics are repeated here. Nevertheless, we have no reason to suppose that the summary of results would have been very materially altered if the figures of the daily strength of inoculated and uninoculated had been based on an actual census, instead of being arrived at by a computation, and, in these circumstances, we do not doubt that the inoculations exerted a beneficial influence in Kirki.

Paras. 433–4 of this Report.

IV.(6.) *Inoculations in the Khoja Community of Bombay City.*

Inoculations among the Khoja community at Bombay.

69; App. IV. in Vol. I. of these Proceedings.

436. We may now pass on to consider the case of the inoculations among the Khoja community of Bombay, regarding which Mr. Haffkine has prepared a special Report, reproduced in an Appendix to our Proceedings. The inoculations were begun on December 27th, 1897, and 33 persons were inoculated on that date, 33 on the 28th, 53

on the 29th, and so on, the inoculated on the last day of February numbering 4,719. During the following seven and a half weeks the number increased only by 465, and the total number of inoculations among the Khoja community in the first five months of 1898 was 5,184. The above were inoculated gradually, and the number includes Khojas who were re-inoculated during 1897–8, after having been previously inoculated in the outbreak of 1896–7. Khojas inoculated in 1897, but not re-inoculated in 1898, were on the other hand reckoned among the uninoculated. According to Mr. Haffkine's calculations, 8,146 remained uninoculated, and the average daily strength of inoculated people was 3,814 during the period covered by his Report, namely, from 27th December 1897 to 20th April 1898. I. 337.

Mr. Haffkine's estimate of Bombay Khoja population and his statement of results of inoculation. I. 337.

A census taken by the Khoja community in the beginning of 1898 showed the total community to consist of 9,350 people, but as, on account of the epidemic, a certain number of families may have been away when the census was taken, the above number, Mr. Haffkine thinks, is, perhaps, not absolutely accurate. He, therefore, estimated the number of Khojas as follows:—"The annual Khoja mortality in years free from plague, as registered in the burial-ground books of the Jamat office, was:—

In 1892 - - -	385
In 1893 - - -	301
In 1894 - - -	335
In 1895 - - -	349

giving an average of 342 deaths in a year. The mean mortality of the population of Bombay is close upon 35 per mille per annum. Counting for the Khojas a mortality per mille per annum of 25 only, the average of 342 deaths a year gives a population of 13,680, which is likely to be higher than the actual number. During the epidemic of plague which preceded the 16½ weeks under consideration, the Khojas had 350 deaths in excess of their average mortality. The above number of persons in the community should, therefore, be reduced by 350, giving a population of 13,330."

I. 337. Mr. Haffkine states that "during the 16½ weeks between the 27th December 1897 and the 20th April 1898, 184 deaths in all occurred in the Khoja community. Of these, six, including two of plague, took place in Khojas inoculated in the epidemic of 1896–97, and not re-inoculated since; seven deaths, including three of plague, occurred in the 5,184 Khojas inoculated or re-inoculated in 1898; and 171 deaths occurred in the uninoculated Khojas. In the years 1892 to 1896, while there was no plague in Bombay, the mortality among the Khojas during the same part of the year, between the 27th December and 20th April, was 131, 96, 100, 106, and 96 respectively, or on the average 105, in a normal population of 13,680 individuals. In the reduced population of 13,330, as it stood at the beginning of the period under consideration, it should have been proportionately 102. The advent of the plague may have altered the course of the mortality, viz., the liability to deaths from other causes than plague, may have been influenced by the fact that, during the plague year preceding the period under consideration, double the usual number of individuals had been carried away by death. The normal mortality must have been also reduced by a part of the community having left the city. Admitting, however, that, of the total number of 184 deaths (during the spring of 1898), fully the usual proportion of 102 died of other causes than plague, there remain 82 deaths in excess of that number which are attributable to plague alone; 64 of this number were actually acknowledged as plague deaths by the relatives of the deceased, or certified as such by the Khoja Jamaat books. Of the 102 deaths attributable to other causes 4 occurred in inoculated this year (1898), 4 in inoculated last year (1897), and the rest, 94, in uninoculated. Of the 82 deaths attributable to plague, 3 occurred in inoculated this year, 2 in inoculated last year, and 77 in uninoculated." After making such allowances as he thinks necessary for the correction of the figures, Mr. Haffkine himself claims "a difference of 89·7 per cent. of deaths from plague in favour of the inoculated part of the community, and of 73·3 per cent. of deaths from what has been returned as 'other causes' in favour of the same part of the community." I. 338.

Critical examination of Mr. Haffkine's estimate of number of Bombay Khojas.

With regard to the figures which Mr. Haffkine has adopted as representing the total number of Khojas present when inoculations began, we note that he has designedly under-estimated the rate of mortality used for his calculation, by assuming it to be only 25 per mille per annum, and that he has thus over-estimated the Khoja population

and the number of uninoculated people comprised in it. This exaggeration of the uninoculated number brings out the percentage of plague incidence among them at an unduly low figure, and, therefore, operates to the disadvantage of inoculation in the comparison which Mr. Haffkine has made. Mr. Ismail Jan Mahomad, a Khoja medical 17,799-800.
practitioner in Bombay, who appeared before us as a witness, thought that there were in the City about 10,000 Khojas, of whom half had been inoculated. Moreover, a calculation upon the average mortality rate of the City, 35 per mille per annum, gives us an estimate that the Khoja community amounted to 9,770 persons. This figure closely approaches the result of the census of 1898.

Critical examination of statistics of mortality among Bombay Khojas.

In view of all the considerations which we have had before us, we have in the following calculations adopted as representing the total population of the Khoja community, the figure of 9,770 persons. Assuming, therefore, that the average strength of the inoculated Khojas during the period of observation was, as Mr. Haffkine puts it, 3,814, we arrive at an average strength of 5,956 for the uninoculated. If we distribute upon these strengths the deaths which are recorded in the books of the Khoja community, as having occurred during the period of observation from plague and from general causes, we arrive at the following results :—

——	Average Strength.	Deaths from Plague.		Deaths from General Causes.	
		Number.	Percentage.	Number.	Percentage.
Uninoculated - -	5,956	61	1	116	1·9
Inoculated - - - - -	3,814	3	·08	4	·1

This table shows that among the inoculated deaths from plague were 12½ times less numerous, and deaths from general causes were 19 times less numerous, than among the uninoculated. *Primâ facie*, therefore, it would appear that Mr. Haffkine's anti-plague inoculation protects against plague, but that it protects more against ordinary diseases. This result is so striking and so difficult to accept that we first addressed ourselves to the task of inquiring whether the inoculated were a picked body, and whether the uninoculated contained a large proportion of the sick and feeble, and of the very young and very old. Surgeon-General Harvey, I.M.S., who made a special 26,438.
personal inquiry into the results of the inoculations performed in the Khoja community, was of opinion that, in the main, the explanation of the disproportion between the deaths from general causes among inoculated and uninoculated Khojas must be sought in the assumption that in many families the sick, the weak, the elderly people, and the children, did not present themselves for inoculation, and that only the strong and healthy undergo the operation. In view of this opinion, we have tested the proportions in which the different age groups were represented among the inoculated and the uninoculated Khojas respectively. For this purpose we have made use of the figures given in Appendix I. in Mr. Haffkine's Report, which we may presume to I. 338.
give with approximate accuracy the relative numbers of persons of different ages among the inoculated and the uninoculated Khojas. We find that on the total number of Khojas present in March the percentages of children under seven, of old people of 61 years of age and upwards, and of persons of intermediate ages respectively were 19, 3½, and 77½ among the uninoculated, and were 16, 1½, and 82½ among the inoculated. These percentages indicate that, in point of age at least, the two communities were not sensibly incomparable. In view of these percentages the next point to determine was whether the excessive mortality from general causes assigned to the uninoculated was really due to excessive deaths in any particular class of the uninoculated community. To determine this we have made an examination of the details contained in Mr. Haffkine's Report. We have computed the average strength among the inoculated and uninoculated, of children under seven and of old persons of 61 years of age and upwards, upon the basis of the percentages of these persons that we have already noted as having been present in the whole Khoja community in March. Further, we have determined from the nominal rolls appended to Mr. Haffkine's Report, the numbers of deaths from I. 339-44.
general causes that were attributed to each of these classes of the community.

69. Moreover, basing ourselves on Mr. Haffkine's statement that the rate of mortality from general causes for the period of the year at present under consideration has in a series of years closely approximated to the rate of mortality for the whole year, we have expressed the death rates in the different classes in the form of a rate per mille per annum. Finally, on the basis of a death-rate of 35 per mille per annum, which is the average death-rate of Bombay, we have, for the purposes of comparison, added an estimate of the number of deaths which might have been expected on the average strength of the inoculated and uninoculated respectively, if they had been in all respects comparable communities The results of our calculations are set forth in the following table:—

—	Uninoculated.			Inoculated.		
	Average strength.	Recorded deaths from general causes.		Average strength.	Recorded deaths from general causes.	
		Number.	Rate per mille per annum calculated on the total average strength.		Number.	Rate per mille per annum calculated on the total average strength.
Children under seven - -	1,120	33	18	610	1	·8
Persons of intermediate ages -	4,622	62	34	3,151	3	2·4
Old people of 61 and over - -	214	21	11	53	0	0
Total - - - - - - -	5,956	116	63	3,814	4	3·2
Numbers of deaths that might have been expected at a death-rate of 35 per mille per annum - -	—	61	—	—	41	—

From this table it will be apparent that excessive mortality from general causes occurred in all three classes of the uninoculated community. The difference between the mortality assigned to the inoculated and the uninoculated will appear very clearly if we contrast the death-rates, which the mortality recorded in the different age-groups of the inoculated and uninoculated gives on the average strength of these classes. While among uninoculated persons of 61 years of age and over, whose average strength was 214, the number of recorded deaths amounted to 21, giving a rate of 313 per mille per annum, no death whatever is recorded as having occurred among an estimated strength of 53 inoculated persons of similar age. The uninoculated children, whose average strength was 1,120, are reported to have lost 33, at a rate of 95 per mille per annum, while 610 inoculated children are reported to have lost only one, at the rate of 5 per mille per annum. In the case of the adults, 4,622 uninoculated are reported to have lost 62 by death, at the rate of 43 mille per annum, while 3,151 inoculated are reported to have lost 3, at the rate of 3 per mille per annum.

Conclusions from figures regarding inoculations among Bombay Khojas.
I. 338.

In view of the facts that are thus summarised here, Mr. Haffkine sums up the case of the Khojas in his Report, as follows:—"After making all allowances for inaccurate certification of deaths in the uninoculated group, with which the inoculated is being compared, and admitting that a part of the causes of deaths in the uninoculated may be due to a certain number of sickly people having abstained from inoculation, the result still contains an indication that besides the protection against plague, this inoculation influences also favourably the resistance to certain other diseases than plague." We find ourselves in agreement with Mr. Haffkine in holding that the difference in mortality among the inoculated and uninoculated cannot be fully accounted for, either by the excess mortality of the uninoculated children and old people, or by the incorrect assignment of plague deaths among the uninoculated to general causes. Such incorrect assignment, if it occurred unwittingly among the uninoculated, would have occurred also among the inoculated, and there was no room for it to have occurred among the inoculated. Therefore, there remains to be considered, of the explanations offered by Mr. Haffkine, only the suggestion that his anti-plague inoculation exercises a protective influence against diseases other than plague. This question is discussed elsewhere in this Report. We cannot, however, accept Mr. Haffkine's view that the low mortality among the inoculated can be accounted

Section IX. of this Chapter.

for on this hypothesis. It seems to us very probable, on consideration of all the circumstances, that the figures of mortality, which have been given above, must be accounted for by assuming that deaths which occurred among the inoculated were wrongly assigned to the uninoculated.

Results obtained in the Bombay Khoja community after period comprised in Mr. Haffkine's Report.

The period referred to in Mr. Haffkine's Report extends over 16½ weeks, namely, to the 20th April 1898, and Mr. Ismail Jan Mahomad has endeavoured to collect the figures of the mortality in the Khoja community from the 20th April 1898 to December 21st of the same year. He states that in the period in question out of 5,000 inoculated persons, 22 got plague, and 26 died of other diseases, while of a similar number of non-inoculated, 44 died of plague, and 218 of other diseases. In the books of the Khoja community, however, only four persons are entered as having died from plague. These books Surgeon-General Harvey told us "are extremely inaccurate as regards causes of death;" referring to these, he said: "some of the entries are absolutely ridiculous." Mr. Ismail Jan Mahomad estimates at 22 the number of inoculated persons who died of plague, because, from his investigations, he is of opinion that some persons entered in the death register by the practitioners as having died of "brain-fever" had really died of plague. Further, he believes, that of the 218 uninoculated Khojas entered as having died from other diseases, 90, at least, had died from plague. It will be plain that no accurate conclusion can be drawn from statements like these, which are founded merely upon impressions. Asked how he accounted for the enormous mortality from general causes among non-inoculated people, as compared with the inoculated, Mr. Ismail Jan Mahomad advanced the same explanations as have been dealt with in reference to the period covered by Mr. Haffkine's figures, that sick and elderly people, as well as children, did not get inoculated. The criticisms made above regarding Mr. Haffkine's figures apply equally to the figures put before us by Mr. Ismail Jan Mahomad, and we need not discuss these in detail.

17,798.
17,804.
17,806.
26,435.
17,806.
17,808–9, 17,816.

Feeling of Bombay Khoja community regarding inoculation.

We may note that the feeling of the Khoja community towards inoculation was the reverse of hostile. Surgeon-General Harvey told us that the Khojas have a most extraordinary belief in the efficiency of inoculation, so that many of them have been re-inoculated, some as often as five times. Inoculation among them was encouraged by their Chief, His Highness the Aga Khan. It is not impossible that religious belief and loyalty to their leader may have had a powerful influence in prepossessing the Khojas in favour of inoculation. A bias in favour of inoculation, like a bias opposed to it, is, especially in an Indian community, not unlikely to result in the intentional or unintentional production of one-sided statistics.

26,435.
12,965.
II. 423.

Nevertheless, quite apart from the statistics put before us, which we think inaccurate, we do not doubt that inoculations had a good effect, inasmuch as much weight must be allowed to the opinions of a community so intelligent as that of the Khojas regarding the practical effects of Mr. Haffkine's prophylactic fluid as tested by them in the presence of plague.

IV.(7.) *Inoculations in the Umarkhadi Common Jail, Bombay.*

Inoculations in Umarkhadi Common Jail.

437. We may proceed now to discuss the test to which inoculation was submitted in the Umarkhadi Common Jail at Bombay. Before inoculation was offered to the prisoners, three cases, all fatal, occurred in this jail, namely, two on the 31st December 1897, and one on January 1st, 1898. On January 1st the 402 prisoners present in the jail were questioned as to their willingness to be inoculated. It was understood that all consented to undergo the operation. They were then paraded, and every second man or woman, without distinction, was picked out for inoculation. When their turn came, two persons refused to be inoculated. Thus out of the 201 to whom it was offered 199 prisoners were inoculated. The conditions of life of the inoculated and uninoculated prisoners were so arranged that there should not, in Mr. Haffkine's words, "be a single circumstance constituting a difference in the condition of the inoculated and uninoculated."

69.
III. 660 (*a*).
20,311–6.

Results of inoculations.

In considering this outbreak, we may confine our attention to the cases of plague which occurred among the prisoners present in the jail at the time of inoculation, though some other cases occurred among prisoners subsequently admitted. The course of the outbreak, so far as it concerns us, is thus stated in Mr. Haffkine's words:— "The plague continued for about a month; and on 11 different days there occurred 13 cases. During that month a certain number of prisoners were discharged, and others

69.

admitted to the jail. Taking day by day the number of inoculated and uninoculated who remained in the jail during that month of plague, from the original group of 402 prisoners, the average daily strength of the inoculated appears 147, and of the uninoculated 127. The number of inoculated who stayed in the jail all through the epidemic was therefore larger by about one-seventh than that of the uninoculated. All the 13 cases of plague occurred among the prisoners of *the original group* who were present in the jail on the day of inoculation. . . . Therefore the distribution of the cases of plague among the inoculated and the non-inoculated represents the distribution of the two original absolutely comparable groups of people which I have described. Ten of the 13 cases were among the smaller number of the uninoculated, and six of these ten died. There were three cases amongst the larger number of 147 inoculated, and all three recovered." These statements are borne out by the official figures with which we have been supplied, except on two points, which do not affect the general results of the statistics. The first of these is that plague continued for more than a month, as will be apparent from the dates of attack given below. The second point is, that in the official figures the number of cases among the uninoculated is given as nine (with five deaths) instead of ten (with six deaths). Mr. Haffkine has explained that the extra man included in his figures was one who was present when the inoculations were performed, but was attacked with plague immediately afterwards, and we think that, in view of this fact, it would be well to exclude this case from consideration, as he had already contracted plague before the inoculations were done.

III. 441-4.

III. 660-1 (*b*).

III. 441-4.

The dates on which plague cases occurred in the jail after inoculation are of interest. Among the groups of inoculated and uninocculated prisoners with whom we are dealing, no cases at all occurred in the interval from the 1st to the 16th January. On the 7th January the whole of the convicts had been turned out of the buildings, in which the original three cases had occurred, and were made to sleep in the open for from 10 to 15 days. In the 14 days dating from the 17th January to the end of the month there occurred among the uninoculated 8 of the 9 cases we have referred to above, while no cases occurred among the inoculated. On the 2nd February there occurred the last of the cases among the uninoculated. The three cases among the inoculated then occurred, the first on the 10th February, the second on the 28th February, and the third and last on the 18th March. We find that the average monthly strength of the inoculated and uninoculated prisoners of the original groups was 92 and 99 respectively during the months of February and March. Thus the incidence of plague in these two months was three times as great in the inoculated as it was in the uninoculated. This, however, must not be allowed to obscure the important fact that, during the whole period of the outbreak, the number of attacks among the inoculated was only one-third of the number among the uninoculated, and that the disease among the inoculated was remarkably mild, resembling mumps more than plague, though the cases among the uninoculated were of average severity.

69; 7236 (I.) and (II.).

IV.(8.) *Inoculations in Undhera.*

Surgeon-General Harvey's account of the inoculations at Undhera.

438. The last of the examples of the effects of inoculation which Mr. Haffkine personally investigated, was that of Undhera. Surgeon-General Harvey, the Director-General of the Indian Medical Service, submitted to the Government of India a report upon this case, from which we may quote the following narrative of the course of events:—"Undhera, a village about six miles from Baroda, was attacked by plague in January 1898. On the 5th February a careful census was taken and showed a population of 1,029. Up to and inclusive of 14th February, 79 plague deaths occurred, leaving 950 people to be dealt with. Of these 513 were inoculated, leaving 437 uninoculated. As far as possible an equal number of each sex, age, and family, was done, and as all were living under precisely similar conditions as to sanitary surroundings, food, drink, clothing, etc., the case is the best and most conclusive example yet available of the result of inoculation. Except for the inoculations, all were on the same footing, and the disease had got a thorough hold of the place. The usual sanitary precautions as to segregation and disinfection were carried out, all plague cases being removed to hospital, and every effort made to combat the disease in the usual way. The inoculations were done on the 12th (February), but the following figures are taken from the 15th, so as to eliminate cases incubating plague at the time of the inoculations. Three deaths occurred among the uninoculated between the 12th and 14th inclusive, none among the inoculated. These three deaths, together with two others which might possibly have been due to diseases other than plague, have been eliminated, so that no exaggeration as to the effect of the inoculation may be possible. The results up to

the 2nd April (1898) are as follows, but no case occurred after the 28th March (1898), so that we are probably dealing with a finished epidemic. Between 15th February and the cessation of the disease plague cases occurred in 29 families, living together as already said under exactly similar conditions, save that some were, and others were not, inoculated. These 29 families comprised 135 individuals of all ages, 71 of whom had been inoculated and 64 not. The 71 inoculated had eight cases with three deaths, while the uninoculated had 28 cases with 26 deaths. Had the inoculated been as susceptible as the uninoculated, they should have had 29 deaths instead of three, and the inference seems irresistible that the inoculation saved 26 lives out of this small number, or 89·65 per cent. Taking the whole number inoculated, 513 had eight cases or 1·56 per cent., and three deaths, or ·58 per cent., while the 437 uninoculated had 28 cases or 6·4 per cent., and 26 deaths or 5·9 per cent., just 10 times as many. The protective influence of the inoculations is brought out still more strongly in some particular instances. Thus, in hut 84, ward 4, five persons were inoculated and five uninoculated in a family of 10. The five inoculated remained healthy, while two of the five uninoculated got plague and died. In hut 18 of the same ward three inoculated persons remained healthy, two uninoculated died out of a family of five. In hut 26, also in ward 4, one inoculated person escaped, two uninoculated died out of a family of three. In hut 8, ward 1, four inoculated persons escaped, while the one who remained uninoculated contracted the disease and died. In hut 24, ward 2, out of a family of two, the inoculated member escaped, the uninoculated died. In hut 20, ward 3, one of the three inoculated contracted plague, but recovered, while one of the four uninoculated got it and died. In two out of the three huts where fatal cases occurred among the inculated, a death also occurred among the uninoculated, and in only one instance in the whole did a fatal case occur among the inoculated, while the uninoculated went free. This was in hut 31, ward 4, where one of four inoculated contracted and died of plague, while two uninoculated escaped. These figures have been verified by Surgeon-Major Bannerman, Madras Medical Service, Surgeon-Captain Dyson, Bombay Medical Service, Mr. Haffkine, and myself, case by case and family by family, and seem to me to prove that while inoculation as at present practiced is not an absolute protective either against seizure or death, it is of immense value both as a prophylactic and as modifying the severity of the disease and reducing the case mortality. This was 37·5 per cent. among the inoculated, against 92·85 per cent. in the uninoculated."

Statistics relating to Undhera.

We add here, for convenience of reference, a tabular statement of the results recorded in Surgeon-General Harvey's Report:—

—	—	Strength.	Attacks.		Deaths.		Case Mortality per cent.
			Number.	Percentage.	Number.	Percentage.	
Whole Village.	Uninoculated	437	28	6·2	26	5·9	93
	Inoculated	513	8	1·5	3	0·6	38
Houses in which plague occurred.	Uninoculated	64	28	43·8	26	40·6	93
	Inoculated	71	8	11·5	3	4·2	38
Diminution of mortality in population of whole village						5·3	
„ „ plague infected houses						36·4	

With regard to the methods by which the above statistics were compiled, we may note, in the first place, that the strength of the uninoculated appears to have been ascertained not by a direct enumeration, but by a computation. The census of the village, according to Mr. Mehta, the medical officer who was in charge of plague operations in the Baroda State, was taken on the 5th January 1898, not on the 5th February. Mr. Mehta has made two statements of the population ascertained, both of which differ slightly from the figure given by Surgeon-General Harvey; the difference is not important. The census population was brought up to date when the inoculations were performed by a deduction for persons who had died or left the village, and an addition for births. Different statements have been laid before us as to the number by which the population had actually declined between the date of the census and the date of the inoculations; but the differences are small, and may be neglected. With regard to

14,894.
14,883-97.

4046-8. the mortality which occurred after inoculation, we may note that the keeping of the records, and the diagnosis of the causes of death, was the work of the native Hospital Assistant or Apothecary who was present in the village. This work was checked, as has been indicated above, by a house to house inquiry by Mr. Haffkine, Surgeon-General Harvey, and other officers. These officers came to Undhera on April 2nd, 1898, went into all the houses, and, with the help of a census paper, controlled the statistics.

69, 4049-51, 7872-8. I. 331.

Criticism of Undhera experiment. App. III. in Vol. I. of these Proceedings. I. 333-6.

Attached to Mr. Haffkine's Report on Undhera will be found a series of investigation sheets which give in detail the composition of each of the 28 families, (not 29 as stated by Surgeon-General Harvey), in which plague occurred, and the occurrences of plague in it. We have scrutinised these investigation sheets to control the statements made regarding the comparability of the inoculated and uninoculated in Undhera, and we find that the proportions of the various ages and sexes were evenly distributed among the two classes. The correctness of Mr. Haffkine's figures is further confirmed, after making allowance for the deaths excluded by him from his calculations, by figures separately given to us by Major Bannerman and Mr. H. D. Mehta. The experiment at Undhera appears to us to be the most important experiment regarding the effect of anti-plague inoculations that has as yet been carried out. It is important, because firstly the inoculated and uninoculated persons under observation were fairly numerous, while their numbers were determined with a considerable degree of accuracy; secondly, because the communities of the inoculated and the uninoculated were comparable, and lived under similar conditions; thirdly, because the communities were equally exposed for a period of six weeks to an outbreak of plague which carried off 6·2 per cent. of the uninoculated; and, lastly, because the results set down by the Native Hospital Assistant were checked in the manner described above. The only point which seems calculated to arouse a doubt as to the trustworthiness of the results recorded is the fact that 27 out of 28 persons attacked are said to have died. This certainly is an astonishing mortality, and might be taken as indicating that the village records are seriously inaccurate. If, however, we assume—and, with the exception of Dr. Ruffer, who thinks that the records cannot be accepted as accurate, we do make the assumption—that the checks applied on the spot were sufficient to ensure the detection of really gross errors, then we may deduce two lessons from the Undhera experiment. Firstly, we learn that the number of plague attacks among the uninoculated is much larger than among the inoculated; in this particular case, as the table given above will show, plague attacks were proportionately four times more numerous among the uninoculated than among the inoculated. The second lesson we learn is that the percentage of deaths among the attacked is very much higher among the uninoculated than among the inoculated; in this particular case, as the table again shows, the percentage of deaths among the uninoculated was proportionately 10 times as great as among the inoculated. An indication which is afforded by the figures for Undhera with respect to the duration of the immunity conferred by inoculation, will be referred to in a subsequent portion of this Report. A fact which invites notice in the table given above is the large percentage of the inoculated who suffered in the houses brought into the investigation sheets, as compared with the percentage who suffered in the village as a whole. We cannot, however, in this case, as in the case of some of the houses in Daman, conclude that this high percentage is referable to the greater liability of inoculated persons to contract plague when they are living in infected houses. It would appear that only one of the eight inoculated persons attacked was attacked in a house in which there had already been a case of plague. Therefore the percentage of attacks among the inoculated residents of the infected houses in Undhera is not a trustworthy index of the liability of inoculated persons to contract plague in infected houses.

4043-5, 14,912.

V. HISTORY OF CASES IN WHICH INOCULATION WAS RESORTED TO ON A LARGE SCALE, WITH CRITICISM OF STATISTICAL RESULTS PUT FORWARD IN THESE CASES, AND CONCLUSIONS TO BE DRAWN FROM THEM.

V.(1.) *The Town of Hubli.*

Inoculations at Hubli.

439. The preliminary experiments which we have discussed above had afforded sufficient proof of the efficacy of inoculation to induce the authorities to take advantage of a serious outbreak of plague at Hubli in May 1898 for testing the value of inoculation on a large scale as a plague measure. We had an opportunity of examining many of the persons employed in this work, more especially Mr. Cappel, the Collector of the district, and Captain Leumann, I.M.S., who had been in charge of the operations.

1955, 2428-34, 2471-2, 3055, 3158-9.

Hubli was one of the first towns in India where an attempt was made to combat plague by the inoculation of the whole population of an infected place, and we have therefore to carefully consider the results obtained. Every effort was made to

19,826–8, 19,888, 23,375. I. 398 (III.).
3164, 3187.
App. XV. in Vol. I. of these Proceedings.
I. 404–5.

encourage inoculation, and, in particular, re-inoculation, both by the application of a great deal of moral persuasion and also by the grant of certain material advantages to inoculated persons. The policy adopted was to relax in favour of the inoculated the severe plague measures which were enforced with regard to the non-inoculated. The uninoculated inmates of houses in which plague cases occurred were taken to segregation camps, and were detained there for 10 to 15, and at one time 18, days; uninoculated persons living in an infected quarter were liable to removal to health camps; uninoculated persons, whether removed originally to segregation or to health camps, were not permitted to return to live in the town unless they became twice inoculated, even though their houses and effects had been disinfected; uninoculated persons could not leave Hubli by rail, and an attempt was made to prevent them leaving by road, and such as got away were liable to detention at other places. Persons once inoculated were treated in these respects like the uninoculated, and a single inoculation was regarded merely as a step to securing the advantages of double inoculation, without which the district authorities were not satisfied that protection was conferred. The twice inoculated, on the other hand, were not segregated except during the time necessary for the disinfection of their property and houses, and were sometimes allowed to re-occupy their houses on the same day as that on which they were removed from them for their disinfection; and the twice inoculated were freely granted passes which enabled them to leave Hubli, and to a large extent guaranteed them against restrictions on travelling in other districts. The result to be expected was attained, and a very large number of the people became inoculated, all but a small part of the inoculated submitting to the operation twice. As the work proceeded statistics regarding its progress and effect were collected, which have been put before us by Mr. Cappel in his evidence, and by Captain Leumann in a Report which he wrote upon the inoculations at Hubli. The object of these statistics is presumably to permit of a calculation of the exact measure of advantage which was gained from inoculation, and Captain Leumann in his Report does, as a matter of fact, work out numerical statements on which he bases a claim that in respect of plague mortality the advantage in favour of the twice inoculated over a period of seven successive weeks amounted to more than 95 per cent.

Mr. Cappel's statistics regarding inoculations at Hubli.

25,151.

The table which was furnished to us by Mr. Cappel as a corrected record of the statistics contains figures for each week commencing with that ending on the 17th June 1898. Details for weeks preceding that week are not given, as inoculations were commenced on a large scale only in the middle of May, when the outbreak of plague began to assume serious proportions. The statement is as follows:—

Weeks ending	Population for the Week.	Inoculated.			Uninoculated.	Attacks in					Deaths in				
		Once.	Twice.	Total.		Once inoculated.	Twice inoculated.	Total inoculated.	Uninoculated.	Total.	Once inoculated	Twice inoculated.	Total inoculated.	Uninoculated.	Total.
Up to June 17 -	47,427	2,323	531	2,854	44,573	Details of these corrected figures cannot be found.		1	123	124	—	1	1	106	107
„ „ 24 -	47,082	3,368	2,220	5,588	41,494			2	28	30	2	1	3	22	25
„ July 1 -	47,485	4,487	3,956	8,443	39,042			1	37	38	1	—	1	29	30
„ „ 8 -	46,537	5,057	5,420	10,477	36,020			4	52	56	3	3	6	55	61
„ „ 15 -	46,518	5,974	7,289	13,263	33,255			8	58	66	4	2	6	34	40
„ „ 22 -	45,240	6,565	8,959	15,524	29,716			13	100	113	1	6	7	82	89
„ „ 29 -	43,809	9,386	10,311	19,697	24,112			21	145	166	6	9	15	100	115
„ August 5 -	43,707	10,016	12,660	22,676	21,031			22	169	191	7	9	16	140	156
„ „ 12 -	42,768	11,339	15,845	27,184	15,584			37	317	354	5	14	19	272	291
„ „ 19 -	40,441	10,265	19,491	29,756	10,685			69	350	419	30	31	61	386	447
„ „ 26 -	39,400	9,671	23,362	33,033	6,367			66	446	512	21	20	41	371	412
„ September 2 -	38,210	7,569	26,547	34,116	4,094			32	393	425	8	20	28	328	356
„ „ 9 -	38,382	6,798	28,671	35,469	2,731			47	261	308	11	23	34	227	261
„ „ 16 -	38,408	6,381	30,911	37,292	1,116			55	153	208	7	40	47	133	185
„ „ 23 -	38,408	6,567	31,638	38,205	937			35	106	141	11	44	55	106	161
„ „ 30 -	39,315	6,820	31,872	38,692	603			28	76	104	4	16	20	58	78
„ October 7 -	39,500	5,258	33,963	39,221	279	4	11	15	41	56	4	10	14	40	54
„ „ 14 -	39,600	5,217	34,527	39,774	200	3	17	20	14	34	3	15	18	18	36
„ „ 21 -	39,953	5,286	34,763	40,049	200	—	6	6	11	17	—	6	6	11	17
„ „ 28 -	40,453	4,196	35,040	40,236	217*	1	4	5	3	8	1	4	5	3	8
„ November 4 -	40,693	5,100	35,229	40,329	364	—	2	2	7	9	—	2	2	6	8
„ „ 11 -	41,164	5,116	35,348	40,464	700	—	2	2	2	4	—	2	2	2	4
„ „ 18 -	41,643	5,117	35,397	40,514	1,129	—	—	—	2	2	—	—	—	2	2
„ „ 25 -	42,206	5,214	35,558	40,772	1,434	—	—	—	—	—	—	—	—	—	—
„ December 2 -	42,640	5,157	35,959	41,116	1,524	—	—	—	3	3	—	—	—	3	3
Average - - -	42,040	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total -	—	—	—	—	—	—	—	491	2,897	3,388	129	278	407	2,539	2,946

* The rising figures represent new comers.

These figures are summed up by Mr. Cappel in a statement that the percentage of 25,151. the total plague-deaths in Hubli was 7 per cent. on a population taken, for the period covered by the statistics, as 42,000. Of the total plague deaths $\frac{3}{70}$ths are assigned to the once inoculated, $\frac{6}{70}$ths to the twice inoculated, and $\frac{61}{70}$ths to the uninoculated.

The figures in this statement are not the same as those given by Captain Leumann in his Report, but this is to be expected from the fact that Captain Leumann's Report 3056–65, 23,143–50. refers to weeks that ended three days before the weeks adopted by Mr. Cappel. Mr. Cappel, however, has informed us that his figures have been reconciled with those of Captain Leumann, and it will therefore suffice for us now to confine our consideration mainly to Mr. Cappel's corrected table which we have printed above.

Criticism of Hubli figures.

Four sets of figures are essential in every case in which a numerical estimate is to be formed of the relative immunity of the inoculated and the uninoculated. These are the total numbers respectively of the inoculated and the uninoculated comprising the population under observation, and the totals of attacks, or, as the case may be, of deaths, in each of the two categories of inoculated and uninoculated respectively. Mr. Cappel's statement purports to give accurately the four sets of figures required, and we have therefore now to consider the extent to which the figures are reliable and capable of use in calculating the exact advantage obtained by inoculation in Hubli.

Method of collecting information in Hubli.

A census of the town was taken under the directions of the Collector some time after the plague had commenced in October 1897. This census forms the basis of the statistics which were collected during the subsequent course of the epidemic. 25,157–60. A procedure similar to that adopted for taking the Imperial Census of 1891 was followed, and, though Europeans were not especially employed to supervise it, we have no reason to doubt that the census of 1897 gives a fairly accurate estimate of the number of people present in Hubli at the time when it was taken. The population was found to be near that ascertained in 1891, but we are not in possession of exact information regarding this point. The census was thoroughly revised when plague 20,172–6. began to get bad, and from that time onwards an attempt was made to keep it up to 1665–6, 3174–8. date, and to check, by a weekly revision, the fluctuation in the population which was 19,870–3, 20,811–3. caused by the movements of the people. To facilitate the revision, the town which contained about 12,000 houses, was divided into sub-divisions and wards, each of the latter having from 90 to 120 houses in it, and being under the charge of a supervisor. On a fixed day every week it was the duty of the supervisor to visit every house in his charge, and to check and correct for each house the entries which stood in his census books regarding it. In addition to his weekly visit the supervisor was instructed to make daily inquiries in his ward, and to note the names of all persons arriving in or leaving the ward, and all information which could be gathered regarding the distribution of the people between inoculated and uninoculated, and regarding the occurrence of plague attacks and deaths among these classes. The weekly visit was intended for a thorough revision of the information collected day by day, and the supervisor was instructed to call out and actually verify the presence of all persons living in the house at the time of his visit, and, after inquiry, to make appropriate entries in his census book against the names of all previously recorded inmates who 2523–7, 3123–30, 3166–7. were found to be absent. The weekly revisions of the ward lists finally reached the Chief Plague Officer, and were used by him for a compilation of the population of the whole town.

Criticism of method of collecting statistics at Hubli, and notice of certain discrepancies of minor importance.

1589, 3174–8.

Before passing on to criticism of the statistics thus collected, it will be well to note certain points with regard to the agency employed in collecting them. Most of the supervisors at one time were volunteers; the work of revising the census was rendered difficult at the most important time by panic due to the fear of the plague; some of them ran away and had to be replaced; during the rains it was difficult to keep them up to their duty; and only one European officer was available to supervise and control the proper working of the organisation.

In some weeks the statistics compiled are obviously wrong as the figures stand in Mr. Cappel's table. Thus, the numbers of the inoculated and uninoculated population, added together do not in the case of four weeks—those ending on the 23rd and 30th of September, and on the 14th and 21st of October—correspond with the total population of the town. Indeed, in the last of the weeks just referred to, the number of the inoculated alone is stated to be 40,049, though this is in excess of the total population, which is given as 39,953 only. We are, however, not disposed to lay much stress on points like this as arguments to show that the figures actually returned by the supervisors were wrong. The discrepancies we have pointed out may be due to simple clerical errors, as is perhaps indicated by the repetition of the number for the preceding week in the case of the total population on the 23rd September, and by a similar repetition in the case of the uninoculated on the 21st October. It is sufficient simply to mention these discrepancies.

Criticism of estimate of uninoculated population of Hubli.

Much graver doubts regarding the accuracy of Mr. Cappel's statistics are awakened by the fact that in the table he originally gave us the plague mortality of the uninoculated, calculated on the census figures, amounted to 20 per cent. in a period of eight successive weeks,—a plague mortality unprecedented in any urban community in British India. I. 65. Though in the revised table put before us the plague mortality among the uninoculated has been brought down to 20 per cent. in a period of 30 successive weeks, still we think that this mortality, in a small community of uninoculated persons, interspersed among a large number of protected persons, is so large as to make it incumbent upon us to examine the figures very carefully. The first important point to be considered is the accuracy of the figures representing the respective numbers of inoculated and uninoculated people in the population. The latter had every reason to avoid getting themselves registered 2521, 3169–71. on the supervisors' census lists. We have already described the policy which was adopted towards them, and a reference to what we have said on the subject will explain that concealment on their part was only to be expected. That they did endeavour to hide themselves is proved by the evidence of Lieutenant Keelan, who directly supervised the census operations; he allowed that when a plague officer appeared, uninoculated 19,890. persons escaped through the back door. That the error among the uninoculated may have been considerable, and is in reality indeterminable, is indicated by the estimates formed of the maximum number of uninoculated people in the town by various witnesses. The minimum number given in the table is 200, while for 14 weeks the table shows that less than 5,000 uninoculated people were in the town, their numbers being given as under 2,000 from the week ending on the 16th September to the last week for which we have a record. Mr. Cardoz, a medical officer employed in Hubli 2488–92, 2518–9. during the outbreak, gave us his opinion that the minimum number of uninoculated never fell below 6,000 or 8,000. Lieutenant Thomas, who was engaged in disinfection 23,461–2. duties in the town, thought that the uninoculated population was about 5,000, and that it did not go below 5,000. His statement, however, like that of Mr. Cardoz', can only be accepted as showing that the general impression left on the minds of officers on the spot was that the census gave an incorrect idea of the number of the uninoculated. Lieutenant Keelan, who was directly responsible for the control of the census operations, was in an exceptionally good position to judge. He, speaking of the middle of September, when Mr. Cappel's figures put the numbers of the uninoculated at 1,116, stated, "I should have said by the figures I had then that there 19,849–51. were about 3,000 or 4,000 who had not been inoculated." In answer to another question, however, Lieutenant Keelan said that "the census which was sent in was 19,891. really correct for each division to within 50 or 100." Inasmuch as there were, we understand, about 10 divisions, this, we may note, would give us a much lower estimate 19,796. of the number of the uninoculated present in the town than that of 3,000 to 4,000 quoted above. But inasmuch as the error would be proportionately greater among the uninoculated than among the inoculated, the statistics regarding them would be seriously vitiated even by an error of 50 to 100 in the enumeration of each division.

Criticism of estimate of inoculated population of Hubli.

The case of the inoculated differed materially from that of the uninoculated, for they had every reason to get themselves recognised as inoculated, and doubtless took care to be registered upon the census. The doubt in their case is that the census rather exaggerated than understated their numbers. As we shall show later on, the Indian Para. 472 of this Report. public has generally resorted to inoculation to escape other plague measures. The chief value of inoculation, from their point of view, is not the protection it affords. They have, therefore, been anxious to use devices to get the privileges of inoculation, without undergoing the pain and inconvenience of the operation. With a subordinate agency like that usually available in India (and we have evidence that in connection 23,366, 23,399. with disinfection the subordinate agency in Hubli itself was actually found to be open to bribery), we cannot exclude the possibility of persons being able to induce census supervisors to enter them improperly as inoculated. A few instances came to the 1965, 25,504. notice of the authorities in which personation was resorted to for the purpose of

1966-7, 2482-7, 2513. 2647, 3089, 23,372, I. 408. obtaining the desired privileges. Certificates of inoculation had, it is believed, a marketable value. On the one hand, certificates of single inoculation were occasionally transferred to assist the persons who became possessed of them in obtaining the privileges of double inoculation after undergoing the process only once. On the other hand certificates of double inoculation were occasionally transferred in order that the privileges desired might be thus obtained without any personal inconvenience. We have, however, no reason to suppose that the census figures of the inoculated were to any considerable extent inflated by the addition of persons who improperly obtained certificates of inoculation; the evidence, in fact, points the other way.

Criticism of statistics relating to plague occurrences in Hubli.

So far we have dealt with the statistics regarding the distribution of the population into the classes of inoculated and uninoculated. In passing on to a consideration of the information supplied to us regarding plague attacks and deaths, we may repeat the fact, which has been already noted above, that the authorities depended for this information upon the same inefficient agency as we have described in criticising the general 1656, 1944-5. 2404. accuracy of the census. Moreover, difficulty in the collection of accurate information was experienced because the discovery of plague in a house was necessarily followed up by the application of the prescribed plague measures. The patient, if alive, was removed to hospital; the inmates of the house were segregated; the house was disinfected and unroofed. The milder measures adopted in the case of inoculated persons were still such as to cause considerable inconvenience. Hence there was great inducement to concealment of plague. That the agency employed to collect information regarding the occurrence of plague was unable to successfully defeat this concealment is proved by the fact that, during the most important period of the 1590, 1981, 19,802-3, 19,836. outbreak which is covered by these statistics, it was only in rare instances that plague cases were discovered during life. To conceal the occurrence of deaths, however, appears to have been a matter of considerable difficulty, inasmuch as the removal of 3076-7. all dead bodies was prohibited until they had been inspected by medical officers appointed for the purpose and a death certificate had been issued. But in spite of these rules, deaths also were concealed. An instance of this is the case incidentally referred to by Lieutenant Thomas, the Chief Plague Officer at Hubli, in connection 23,383. with his evidence regarding disinfection. He referred to the case of a house in which, out of 13 inmates, nine, having died of plague, had been buried surreptitiously before information reached the authorities. In such a case it may be doubted whether the people who had died were on the census at all, and whether the deaths when discovered would be correctly classified as inoculated or uninoculated. The principles on which classification was ordinarily made were as follows. When a death came to the knowledge of the authorities, the medical officer appointed for the purpose proceeded to make an inspection of the body. He had first to determine whether the death was or was not due to plague. Very considerable difficulty appears to have been 20,007, 20,014. experienced in many cases in arriving at a correct conclusion, even when the inspection was made by experienced European medical officers, and in the earlier part of the epidemic, when time was available, it was found necessary to have resort to post 3077-8. mortems and bacteriological examinations. Later on, however, when the epidemic was at its height, the task of examining bodies was committed to Assistant Surgeons and Hospital Assistants, and we cannot doubt that many erroneous diagnoses may have been made. A decision as to the cause of death, whether right or wrong, having been arrived at, the next point to determine was whether the deceased belonged to the class 3082-4, 3131-7, 3181-2. of the inoculated or of the uninoculated. Inquiries were made from the relatives, and a search was instituted for a certificate of inoculation. When a certificate was found, or the body of a person identified showed signs of inoculation by the existence of a nodule on the left arm, the deceased was classed as inoculated. When the body of a known person showed no signs of inoculation, and no certificate was forthcoming, the statements of the relatives were accepted, unless on consulting the register of inoculations there appeared to be grounds for doubting these. When the body was that of a person not identified, and nothing could be found out about it, the classification of the death as that of an inoculated or uninoculated person, depended upon the proportion in which the inoculated and uninoculated were represented in the population. This is the statement of Captain Leumann, I.M.S.; but, on the other hand, the statement of 2473-7. Assistant-Surgeon Cardoz, who was temporarily employed on this particular duty, is 2515-6, 2530 that unless a certificate of inoculation was found on a body or was produced by the friends, the deceased was considered to have been uninoculated. Mr. Cardoz added 2480. that there was no inducement for the friends to produce certificates. This we can well believe, for as we have already pointed out, certificates were occasionally transferred by sale to uninoculated persons, and relatives may have sometimes been unwilling to part with certificates on account of the importance which is attached in India to the mere possession of such documents. In cases where certificates were not forthcoming, it seems to us to have been practically impossible to get evidence of inoculation, as the local induration resulting from inoculation would rapidly pass off, and, even if the patient's name was known—which from Captain Leumann's Report, appears to have been the case with reference to all but 5 per cent. of the dead examined in Hubli—it would be an extremely difficult and laborious task to trace a particular case of inoculation in unindexed registers, to which from 500 to 800 entries were added daily by an inadequate staff. We see, therefore, that the statistics of deaths are liable to a considerable error.

I. 400 (xviii.),
I. 409 (E.).
2528.

No exact arithmetical estimate of amount of protection conferred by inoculation can be obtained from Hubli figures.

To sum up, then, we have seen that each of the four data which are essential to a correct estimation of relative immunity may be inaccurate. It is possible that the number of the inoculated has been over-estimated, and it is almost certain that the number of the uninoculated has been understated Moreover, the number of deaths—to say nothing of the number of attacks—assigned to plague is inaccurate, and in the attribution to the inoculated and the uninoculated of deaths assigned to plague there is almost certainly further error. We, therefore, cannot but conclude that it is absolutely impossible to arrive at any exact arithmetical estimate of the relative immunity of the inoculated and uninoculated, and that the estimate put forward by Captain Leumann cannot be accepted as correct.

Comparability of inoculated and uninoculated in Hubli.

We have, however, to consider whether it would not be possible to work out from the figures some approximate expression for the amount of protection afforded by inoculation at Hubli. It would be possible to do this if the errors in the statistics which we have referred to above were not such as to seriously affect the results when expressed in percentages, and if the communities of the inoculated and uninoculated could be regarded as comparable from the point of view of general health. To enable us to come to a conclusion regarding the comparability of the communities we can make use of figures with which we have been supplied by Dr. Winter. These figures relate to the number of deaths from general causes which took place among the inoculated and uninoculated respectively. We learn from them that in the period of 30 weeks, from the 12th May to the 29th November, the uninoculated lost 646 by deaths due to general causes, while the inoculated lost 74 only. We cannot work out from these figures the exact annual death-rate, for we do not know the census figures of the population for the first four weeks included in Dr. Winter's period. But Dr. Winter's figures, taken upon the average strength of the inoculated and uninoculated for the rest of his period, give us a mortality rate from general causes of over 80 per mille per annum among the uninoculated and of only four per mille *per annum* among the inoculated. It is not open to us to assume that deaths among the uninoculated which were assigned in Dr. Winter's figures to general causes were in reality unrecognised plague deaths. We are excluded from making this assumption, because, as we have pointed out above, the number of plague deaths already assigned to the uninoculated is so large as to awaken serious doubts as to its accuracy. We must therefore take Dr. Winter's figures as foreclosing the question of the comparability of the two communities from the point of view of general health. The conclusion that the communities were incomparable is borne out by a consideration of the process of selection which operated in the direction of excluding certain classes of unfit persons from the inoculated community. Candidates for inoculation were often rejected on account of age, disease, and advanced pregnancy. In a town which just before the outbreak of plague had 58,000 inhabitants, the whole body of the uninoculated, when their number was at or near its recorded minimum of 200, must have consisted entirely of persons of the rejected classes. It is precisely during this period that the errors pointed out above in the enumeration of the uninoculated population and in the assignment of plague deaths to the uninoculated must have most seriously vitiated the statistics. On the other hand, a consideration of Mr. Cappel's table shows that during a considerable portion of the period covered by his statistics the numbers of the uninoculated were large. During this period the effect of the errors due to the incomparability of the inoculated and the uninoculated, and to defects in the collection of the statistics cannot, we think, have been large enough to vitiate deductions from the figures expressed in the form of percentages. From this opinion one of us, Dr. Ruffer, dissents, and he thinks that no useful arithmetical estimate of the value of inoculation at Hubli can be made.

1819, 1823-4.
1689-95, 1759-62.
3066-70.

Approximate estimate of effects of inoculation at Hubli, and general remarks

We think that it may be possible to draw some approximate inference from the figures in Mr. Cappel's table, provided we exclude the figures after those for the week ending on the 19th August, after which time the numbers of the uninoculated were small. Moreover, we must exclude also the figures for the earlier weeks included in Mr. Cappel's table. This will be manifest when we consider that the population, which we should here have under consideration, would consist first of two groups of 5,588 and 10,685 persons respectively, who are continuously included (during the period from the 18th June to the 19th August inclusive) in the respective classes of the inoculated and uninoculated, and secondly of a group of some 24,200 persons who are included in the first weeks of the period among the uninoculated and who gradually pass over to the inoculated and are at the end of the period all included among the inoculated. Now, inasmuch as plague was only beginning to gather strength in the earlier part of the period, it will be manifest that this group of 24,200 persons must have been brought more frequently in contact with infection in the latter weeks than in the earlier weeks. Hence the number of cases might have been expected to be greater among these 24,200 people in the later than in the earlier period. Therefore the number of cases which did actually occur among this group in the second period, when they are included in the inoculated, will not, when compared with the number of cases that occurred among them in the first period, when they were included among the uninoculated, give a full measure of the value of inoculation. With a view to eliminating the source of error that would thus be introduced, we have taken as the basis of our comparison only the figures which have been supplied for the period from the 16th July to the 19th August. The comparison thus worked out covers the period which begins when plague became severe, and which ends when the comparability of the inoculated and uninoculated begins to be seriously doubtful. The comparison is as follows :—

—	Average Strength.	Number of Plague Deaths.	Percentage of Deaths on Average Strength.
Uninoculated - - - - -	20,225	980	4·8
Inoculated - - - - -	22,967	118	·5
Diminution of mortality in favour of inoculated -	- -	- -	4·3

According to this table it would appear that 987 lives were saved in Hubli during five weeks. Even if the saving is considerably exaggerated by this calculation, it is still quite clear that a very large number of lives must have been saved in Hubli by inoculations during the whole course of the epidemic there. Moreover, we may note that an arithmetical estimate is not the only criterion by which we can appreciate the value of inoculations. And in Hubli their value is approved by the consensus of opinions of officers who have seen probably far more of this process and its results in practice than any other persons in India, and who, having every facility for forming a sound judgment as to its effect where plague was really virulent, are satisfied as to its great value.

1956-7.
I. 407 (xxx.).

In addition to the results of endeavours made to obtain an exact estimate of the benefits accruing from inoculation to the whole town, two series of data are before us from which it might appear possible to form such an estimate for parts of the town separately. These data relate to the results obtained by inoculation in certain selected houses in Hubli and among the employés of the Southern Mahratta Spinning Mills.

Captain Leumann's investigation sheets for Hubli.

I. 417-28.

The former series is accessible to us in a set of 69 investigation sheets which Capt. Leumann has appended to his report on Hubli. The results are striking, for out of 336 inoculated persons inhabiting the houses to which the investigation sheets related, only 11 were attacked, and 4 died, whereas of 144 uninoculated persons 84 got the plague, and 80 died. The mortality among the inoculated was 1 per cent. and the attacks 3 per cent., giving a case mortality of 33 per cent.; whereas among the uninoculated inhabitants the percentage of attacks was 61 per cent. and the mortality 57 per cent., giving a case mortality 94 per cent. The uninoculated people in these plague houses, therefore, suffered far more severely than the inoculated. But only a very small minority of the plague deaths among the inoculated in the town occurred in the houses in question. For Lieutenant Keelan, who collected 200 cases from which most of the 69 published in the Appendix were selected by Captain Leumann, stated that his 200 selected houses did not contain all the houses in which

1725, 19,829-35.
19,877-88,
19,899-906.

inoculated and non-inoculated people lived together, and in which plague cases had occurred. His instructions were, he said, "to get good cases, houses where several 19,878. had been inoculated, and one or two had not been inoculated. There were a lot of houses where, perhaps one person had not been inoculated, and the others had, and those I should call good cases where only one of the uninoculated got the disease." It is to be understood, however, that Lieutenant Keelan did not reject houses because of the result not being so favourable, but simply that he kept a special look-out for what he called good cases. We are unable to attach any importance to any numerical results deduced from these investigation sheets, for the reason that it is admitted that the houses were subjected to a double process of selection, first by Lieutenant Keelan, and then by Captain Leumann. While they have no statistical value, they are of interest as quite special examples of successful inoculation.

Inoculations in the Southern Mahratta Spinning Mills, Hubli.
I. 407 (xxviii.).

Captain Leumann states that in the Southern Mahratta Spinning Mills a series of inoculations was carried out at the express wish of the Manager, Mr. Narayenrao, who kept careful records and carefully checked the results. On the 21st June there were 1,173 mill hands on the muster roll. We are told that after that date 1,040 were twice inoculated with a death-rate from plague of 22 altogether, or 2·11 per cent.; 58 were inoculated once only, and show a plague death-rate of 13·79 per cent. (8 altogether); while the remaining 75, who refused inoculation lost 20 out of their number from plague, or a percentage of 26·6 per cent. These figures are of no value for computing the relative immunity of inoculated and uninoculated, because we are not informed whether the inoculations were performed simultaneously or at what stage of the outbreak the average strength of the inoculated was reached. But the fact that the mortality among the inoculated is said to have amounted to 3·3 per cent., shows, if the figures are accurate, that the inoculated living among uninoculated inhabitants during an outbreak may suffer considerably from plague.

V.(2.) *The Town of Dharwar.*

Inoculations in Dharwar town.

440. Contemporaneously with the decline of the outbreak at Hubli, a serious outbreak of plague occurred in Dharwar. The population of the town in August 1898 amounted to 38,325, which is in excess of the population ascertained by the Imperial Census of 1571, I. 67. 1891. The policy adopted on the outbreak of plague was the same as in Hubli, that 1610, 1943-5, is to say, stringent measures were enforced against the uninoculated, and these were, 2328-37, 23,747. to a large extent, relaxed in the case of twice inoculated persons. When the plague got a foothold in the town in August, inoculations were pushed to the utmost extent 1974. by the energetic Collector of Dharwar, Mr. Cappel. By the week ending on the 14th I. 67. October, the first for which we have figures, 4,926 people had been inoculated once, and 3,387 persons twice. The inoculations were proceeded with during the outbreak, and by the 4th January 1899, as we learn from a report which has been supplied by Not reprinted with Dr. Hornabrook, who was continuously on plague duty at Dharwar, 17,604 persons these Proceedings. had been inoculated, 11,457 twice, and 6,147 once only. A considerable number 1958. of inoculations were done in the town in the case of villagers who came in specially for the purpose, but in this place we need take no account of these.

Owing to the fear of segregation and inoculation, Dharwar was, to a large extent, emptied of its inhabitants. Influenced by this fear, 18,000 people left the town in one 23,746. week at the commencement of October, and by the beginning of November the census figures show that the population was reduced to about 9,700. The large majority of 1956, 1974-9 those who left the town camped in the fields round Dharwar. The greater part of 1991-4, 2351. those who remained in the town submitted to inoculation, and the condition of things thus brought about was, apparently, the following: Dharwar itself contained a population largely inoculated, while in huts in the fields round about the town there was a larger population mostly uninoculated. The importance of this will be realised when we come to deal with the statistics of the results of inoculation.

Statistics of inoculation in Dharwar town.
I. 67, 1763.
1771

Two series of statistics have been furnished to us. The first is that placed before us by Mr. Cappel, and based on a weekly revision of the census which was carried out after October 19th, in the same manner as at Hubli. The second series, that put in by Miss Corthorn, M.B., who worked at Dharwar during the whole time of the outbreak there, covers the period for the five weeks ending on the 16th November. Mr. Cappel's table does not distribute the population in such a manner as to permit of our basing upon it calculations to determine the relative immunity of the inoculated and the uninoculated. Neither are we able to make such calculations upon the figures for plague attacks and deaths which he gave us up to the 2nd December 1898, and according to which the

uninoculated had had 1,172 attacks, with 916 deaths; the once inoculated had had 115 cases and 42 deaths, and the twice inoculated had had 29 attacks, with 7 deaths. On the other hand, Miss Corthorn's table gives us the number of the inoculated and uninoculated present in the town, and the number of plague attacks and deaths distributed between inoculated and uninoculated persons. The numbers of the population she took from the census, and she made special inquiries to obtain information of attacks and deaths, but none the less her figures in many cases agree with those given by Mr. Cappel for weeks ending two days later than the weeks adopted by her. Miss Corthorn said:—
1763. "I have kept a register as accurately as I could of all the people inoculated. I have kept in touch with the medical officer of the hospital, and I have examined the returns of all the patients going into the hospital who were returned as being inoculated, and I have also got the authorities where I have been at work at different centres to tell me of any people they know whom I have inoculated and who have got plague. I have also got, where possible, the inoculation checks returned and entered in the register of the people that I could get hold of whom I have inoculated and who have developed plague afterwards. Of course, I have missed a good number, but I think I have obtained very fair results. I have got hold of the larger part of the people who have developed plague. I have got hold of all the cases that I could each week, and I have worked out week by week the percentage of morbidity and mortality on the weekly census. I have done it also on my register and compared it with the average population, and I have also done it week by week on the numbers given in the census of the inoculated and uninoculated in the town." Upon the figures she collected she based calculations showing in respect of mortality a percentage in favour of the twice inoculated of from 93 to 100 per cent. The method of calculation employed by Miss Corthorn is that which has been adopted by Mr. Haffkine, and which is criticised in paragraph 454 below. The table compiled by her is as follows:—

Period. Week ending	Population.			Plague Attacks among			Plague Deaths among			Percentage of Reduction in Favour of			
	Uninoculated.	Once inoculated.	Twice inoculated.	Uninoculated.	Once inoculated.	Twice inoculated.	Uninoculated.	Once inoculated.	Twice inoculated.	Once inoculated of		Twice inoculated of	
										Morbidity	Mortality	Morbidity	Mortality
19th October 1898 -	5,748	3,542	2,112	168	17	1	124	7	1	83·5	90·	98·	99·
26th " " -	4,200	3,535	2,428	100	20	8	71	6	1	74·3	89·9	86·	97·5
2nd November " -	3,089	3,074	3,557	61	15	2	52	3	1	75·2	94·2	97·	98·5
9th " " -	2,276	3,184	4,290	25	1	5	24	1	3	97·7	97·7	89·4	93·4
16th " " -	2,132	3,018	4,931	16	4	5	16	2	0	82·	82·3	86·4	100·

Criticism of statistics for Dharwar town.

1976, 1988, 1991, 1996, 2352–8.

Certain sources of fallacy which detract from the accuracy of Miss Corthorn's figures have been pointed out by herself in her statement quoted above. It seems to us, however, in consideration of the evidence of Mr. Cappel and Major Hardy, Chief Plague Officer at Dharwar, that a further serious source of fallacy, and a fallacy which Miss Corthorn has not attended to, is that in the table the population figures refer to the town alone, while the figures relating to plague attacks and deaths include also cases of persons who found their way back to their houses, or were brought into hospitals in the town from the camps around Dharwar. We have not been supplied with the numbers of these cases, but we were informed by Major Hardy that in the last week of November and the first week of December (*i.e.*, in the period almost
2356. immediately subsequent to the period covered by Miss Corthorn's statistics) nearly all the attacks and deaths among uninoculated which came to the cognizance of the authorities, were imported from among the body of uninoculated who were encamped in the fields. It will thus be seen that the statistics must have been seriously vitiated by this source of error. Our attention has, moreover, been drawn by Dr. Hornabrook to another source of error. He, in his report referred to in para. 440 above, speaking of Dharwar, stated that "It is impossible to properly ascertain the number of plague attacks that may occur among inoculated persons, for so many of the people are removed into the jungles directly they are taken ill." If this occurred, and we have no doubt that it did, inasmuch as the stringent plague measures which were adopted must have engendered concealment, we have here again a serious source of fallacy. For the number of plague attacks given for the inoculated

was so small that the removal of even a few of these cases from the cognizance of the authorities would have introduced an important error into the figures.

In view of the many serious sources of error adverted to above, we are of opinion that no reliance can be placed on the arithmetical estimate of the relative immunity of inoculated and uninoculated put forward by Miss Corthorn. But here again, as everywhere where we show reason for discrediting the arithmetical estimates which have been put forward as evidence of the benefits which have been derived from inoculation, we are desirous of making it plain that we are satisfied with the weighty evidence in favour of inoculation, which is afforded by the opinions of those who were on the spot, and had under their constant observation its beneficial effect in warding off plague and diminishing the fatality of the disease.

Inoculations in Dharwar Jail.

Lastly, the inoculations which were performed in the Dharwar Jail may here be briefly referred to, for the outbreaks of epidemic disease occurring in jails are of particular value, as all circumstances connected with them can be accurately controlled. Plague broke out in the jail in October, the first case occurring on the 19th of the month. 2236. Between that date and the 9th November, when the outbreak ceased, six attacks took place, of which five proved fatal. 2259. After the occurrence of three cases, inoculations were resorted to in addition to other sanitary measures. They were commenced on the 23rd October, and all the prisoners were inoculated by the 6th November. 2263-4. Only one case occurred among the inoculated, in a prisoner who was inoculated on the 6th November, was attacked on the 9th November, and was the only person attacked who recovered.

V.(3.)—*The Town of Gadag-Betigeri.*

Inoculations at Gadag-Betigeri.

441. Next after the inoculations in Hubli and Dharwar, it will be convenient to consider the inoculations in Gadag-Betigeri, a third town in the Dharwar district to which the policy of extensive inoculations was applied. The town is not far from Hubli, and is divided into two parts, about one mile distant from each other, each of which had a population of about 13,000 in the beginning of October 1898. 23,680. The total population for the whole town was thus somewhat greater than that, 23,000, ascertained in 1891. One part, known as Gadag, is inhabited principally by agriculturists who have their fields to move into when they vacate their houses, while the other part, Betigeri, contains chiefly residents of the commercial and industrial classes who do not find it so easy to move out of their houses. Plague established itself in the two parts at different times, but though it broke out in Gadag about the middle of October 1898, and did not become serious in Betigeri till it had reached its climax in Gadag, about two months later, we must deal with the figures for the town as a for they were so collected for the purpose of compiling the statistics supplied

Statistics regarding inoculations in Gadag-Betigeri.

ue measures applied were practically the same as in Hubli and Dharwar, ons were pushed by the grant of special privileges to the twice inoculated. sus of the town had been taken in December 1897, and after the outbreak n 18th November 1898, arrangements were made to register the people as uninoculated, and to keep the census up to date by a weekly revision 23,832-6, 23,853-62. tem as in Hubli. Evacuation appears, as in Dharwar, to have been 23,680. d on in the case of the uninoculated. There were, however, many among those who left their houses, and as the result of evacuation, ge extent voluntary, Gadag was practically emptied. We are told who was on plague duty in the town, that "Betigeri, on the other he experience of Gadag. . . . The people of Betigeri made a ulation, and thus avoided the general evacuation of the town by tes of their houses inoculated." We find, however, from estimates 23,727. r. Foy, that a large exodus, amounting to that of 5,800 people out present in October, did take place from Betigeri, and that the e inhabitants of Gadag inoculated was not very much less than in r. Foy informed us that even before the plague obtained a hold of he numbers of once and twice inoculated persons in Gadag-Betigeri were 365 respectively, of whom about 2,000 lived in Gadag. The subsequent ss of the inoculations and the course of the plague among the inoculated and oculated respectively is illustrated by the sets of statistics put before us by . Foy and by Miss Corthorn, M.B., who also was on plague duty in the place. iss Corthorn's statistics cover a slightly longer period and are arranged by weeks. 23,831.

while Mr. Foy's are arranged by months. From both these series of statistics we have compiled the following table :—

—	Population as taken from the Census.				Plague Deaths according to Miss Corthorn.				Plague Deaths according to Mr. Foy.					Remarks.
	Uninoculated.	Once inoculated.	Twice inoculated.	Total.	Uninoculated.	Once inoculated.	Twice inoculated.	Total.	—	Uninoculated.	Once inoculated.	Twice inoculated.	Total.	
1898. Before week ending Nov. 18 -	—	—	—	—	11	0	0	11						
Week ending Nov. 18 -	20,813	2,560	1,696	25,069	5	0	0	5	Up to Nov. 18	37	0	0	37	
" 25 -	17,659	2,916	2,799	23,374	9	0	0	9						
Dec. 2 -	15,473	3,456	3,660	22,592	13	1	0	14	(*difference*	*+ 21*	*0*	*0*	*+ 21*)	The figures given in italics represent the differences between Miss Corthorn's figures and Mr. Foy's.
" 9 -	13,835	3,546	4,275	21,656	7	1	0	8	18 Nov. to					
" 16 -	11,772	3,608	5,186	20,566	14	1	0	15	16 Dec.	52	2	0	54	
" 23 -	8,726	3,676	6,706	19,108	15	1	2	18	(*difference*	*+ 9*	*− 1*	*0*	*+ 8*)	
" 30 -	6,145	3,168	7,173	16,486	27	3	4	34						
1899. Jan. 6 -	3,381	2,360	8,757	14,498	35	1	5	41	16 Dec. to					
" 13 -	2,635	1,905	9,454	13,994	23	2	5	30	13 Jan.	105	7	16	128	
" 20 -	1,766	1,292	10,390	13,448	10	2	5	17	(*difference*	*+ 5*	*0*	*0*	*+ 5*)	
" 27 -	1,135	1,071	10,977	13,183	13	2	4	19						
Feb. 3 -	907	774	11,149	12,830	8	0	7	15	13 Jan. to					
" 10 -	723	709	10,994	12,426	8	0	7	15	10 Feb.	41	5	30	76	
" 17 -	732	585	10,940	12,257	6	0	8	14	(*difference*	*+ 2*	*+ 1*	*+ 7*	*+ 10*)	
Total from beginning of outbreak to 17th Feb.	—	—	—	—	204	14	47	265	Total from beginning of outbreak to 10th Feb.	235	14	46	295	

Criticism of above statistics.
Para. 439 of this Report.

Miss Corthorn's and Mr. Foy's figures for the population are taken from the weekly census; for reasons similar to those discussed in connection with the Hubli census, their absolute accuracy must be doubted. Further, the figures given contain some internal evidence of error, in that the totals of the average weekly strength of the uninoculated, the once inoculated, and the twice inoculated, as calculated from the figures given under these headings, do not together amount to the average weekly strength of the total population. The figures for plague deaths, moreover, do not agree in the two sets of returns which have been given us. Mr. Foy was himself
23,837, 23,863. responsible for classifying as inoculated or uninoculated the cases of patients who died in the hospital, and he was the ultimate authority for the classification, in cases
of doubt, regarding patients who died outside the hospital. Mr. Foy's are, theref
the official figures. Miss Corthorn's figures were, to some extent, obtained b
23,837-9. pendent inquiry. She tells us that she went every day to the hospital to look
cases that came in, and cross-examine the patients and their attenda
whether they had been inoculated or not. Further, where such cross
yielded no reliable information, she went to the census supervisors to con
and obtain their assistance, as they had got to know all the people f
these circumstances, we might have expected that Miss Corthorn's fig
be less than the official figures, and would differ, if at all, only in th
the deaths between inoculated and uninoculated. But, as a matt
Corthorn's figures, from the commencement of plague up to the 10
for which period a comparison can be instituted, give us a smalle
plague deaths than Mr. Foy's figures, as will be seen in the followin

Plague Occurrences from Commencement of Plague to 10th February 1899.	Among Uninoculated.		Among Once inoculated.		Among Twice inocula		
	Attacks.	Deaths.	Attacks.	Deaths.	Attacks.	De	
Miss Corthorn's Figures -	266	198	28	14	86	39	
Mr. Foy's Figures - -	287	235	35	14	104	46	42

In view of the fact that there is a discrepancy between the totals given us for p
deaths in these two estimates, it is manifest that both cannot be correct. But inasm
as the discrepancy does not affect the results when they are expressed in percentag

we have thought it of interest to calculate the relative incidence of plague cases and plague deaths on the inoculated and the uninoculated on the two sets of figures supplied to us. Miss Corthorn's statement allows us to make such a calculation for a period extending from the 18th November to the 17th February, while from Mr. Foy's figures the calculation can be made from the 18th November to the 10th February only. The results which we obtain are as follows:—

—	From Miss Corthorn's Figures.						From Mr. Foy's Figures.					
	From 18th November to 17th February.						From 18th November to 10th February.					
	Average Population.	Attacks.		Deaths.		Case Mortality per cent.	Average Population.	Attacks.		Deaths.		Case Mortality per cent.
		No.	Per cent.	No.	Per cent.			No.	Per cent.	No.	Per cent.	
Uninoculated -	8,075	240	3·	188	2·3	78·2	8,687	239	2·7	198	2·3	83·
Once Inoculated -	2,388	29	1·2	14	·6	48·2	2,528	33	1·3	14	·5	42·5
Twice Inoculated	7,170	107	1·4	47	·6	44·0	6,868	104	1·5	46	·7	44·
Total Inoculated	9,558	136	1·4	61	·6	45·0	9,396	137	1·5	60	·6	44·
Diminution of mortality in favour of the inoculated -			-	-	1·7	-	-	-	-	-	1·	

Quite apart from the question of the accuracy of the data on which these calculations are based there are two points which must be noted. It must be noted, in the first place, that the comparison thus instituted is unduly to the disadvantage of inoculation, inasmuch as plague was relatively less severe in the earlier phase of the epidemic, when the number of the inoculated was below their average strength, than in the later phase when the number of the inoculated was above their average strength. The second point to be noted is that in the later portion of the period of observation the uninoculated population declined to such an extent as to suggest doubts as to whether it was comparable with the inoculated. An incomparability of this sort would, in the comparison which has been made above, operate unduly to the advantage of inoculation. The deduction to be made, if we may set off the error which would be introduced by the inclusion of the earlier period against the error which would be introduced by the inclusion of the later period, is that the uninoculated proved themselves in Gadag-Betigeri to be four times as liable to plague as the inoculated.

V.(4.)—*Villages in the Dharwar District.*

Inoculation in villages of the Dharwar district.

442. In order to complete the consideration of facts relating to the Dharwar district, it will be convenient to notice here two instances of severe village outbreaks in the '-'^t, in the case of which the plague measures ordinarily applied to villages were ted by the use of inoculation. The outbreaks are those that took place in d Huilgol. We have been supplied with particulars regarding them by R. R. Bhardi, who dealt with the plague in the villages in question in an officer on the staff of the district.

Lingdhal. III. 225.

ı brought into Lingdhal some time in July 1898, but the existence of did not come to the notice of the authorities until the 21st August. ıken to number the people and to evacuate the village, and inoculance commenced by Dr. Foy. Evacuation was completed in ten days, 117 cases with 85 deaths had occurred. The inoculations were lly, and a large number of people were operated on on the 7th and and 28th, of September. The population of the village in 1891 was s taken after plague was detected showed that 1,372 people were ese 678 were inoculated, many twice, before the 14th October, after ır primary inoculations took place. After complete evacuation, the l severe, and 318 cases with 287 deaths took place. Of the plague ᵻ after complete evacuation, 34 cases and 31 deaths were assigned . If this is correct, the balance of 284 cases with 254 deaths must among the uninoculated.

ıbers of the inoculated and uninoculated as given to us have been arrived at lowing way. The number of the inoculated was got by taking the total of persons inoculated, without deductions for deaths and emigration. The of the uninoculated was obtained by deducting the number of the inoculated, at as above, from the population of the village ascertained by the census taken lague was detected. Here again no allowance was made for diminution of rs by deaths and exodus. These figures do not even approximately represent erage strengths of the inoculated and uninoculated present during the period of observation. Therefore, they do not afford any basis for a correct arithmetical estimate of the amount of protection conferred by inoculation. None the less, while we appreciate the existence of serious errors in the figures, it seems to us impossible to draw any other conclusion from them than that inoculations must have done much good. The outbreak in Lingdhal was of extraordinary severity, evacuation did not check it, the proportion of the population who submitted to inoculation before the outbreak began to decline was certainly large, and yet the inoculated are reported to have suffered only a little more than one-eighth of the loss which befell the uninoculated after the completion of the evacuation.

Huilgol.
III. 225-6.

The history of the second village which is to be noticed here may be given as follows in the words of Mr. Bhardi. "In the village of Huilgol, with a population of 1,866, both cholera and plague prevailed simultaneously. The first case of plague occurred on the 7th September 1898. Between the 7th and 18th September only eight cases of plague occurred. Between the 19th and 22nd September there were no attacks or deaths from plague. On the 24th September, Dr. Foy examined 11 cases of sickness, but was able to discover plague in only four cases. The other cases were found more or less suspicious and had all the symptoms of cholera. Complete evacuation could not be promptly effected owing to rain and inclement weather. By the 10th October 1898, a greater portion of the village was evacuated, and by the end of October it was completely evacuated. Only a small number of twice inoculated people were allowed to stay in the village. But a large number of cases of plague occurred among the people residing in the village before complete evacuation. Up to the 10th October 170 cases occurred, and between 10th and 31st October 228 cases occurred. Altogether, 398 cases occurred before complete evacuation, out of which 350 proved fatal. After complete evacuation only 45 cases occurred within about a fortnight. About 300 persons were inoculated by Dr. Foy about the 10th September, of whom 35 only were inoculated a second time. Forty-five attacks occurred among the inoculated, of which 31 proved fatal. The records do not show how many cases and deaths occurred among the twice inoculated. But I think that they were few, if not nil."

Here, as in the case of Lingdhal, it is obvious that percentages of incidence worked out on the numbers given as those of the uninoculated and inoculated will be fallacious, but, taking such percentages as a rough guide, we find that the inoculated, in comparison with uninoculated persons living under the same conditions, appear to have enjoyed a considerable amount of protection against attack, though inoculation did not prevent the plague from affecting them severely.

V.(5.)—*Bangalore City.*

Inoculations in Bangalore City.

443. We may now pass on to deal with inoculations in the City and the Civil and Military Station of Bangalore.

Para. 76 of this Report.

Plague broke out in Bangalore City in the middle of August, 1898
31st March 1899, as we have already stated, it had carried off an estimate
6,370 persons, amounting to 7·5 per cent of the normal population. In
large scale was made a prominent feature of the plague policy, a
3261, 3482.
Government on October 4th, issued an order making it practically co
its servants and those attending schools and colleges to be i
3162.
authorities, however, did not insist on double inoculations. C
undergone inoculation once were not removed to segregation cam
3292, 3296-9, 3315-6.
was given for the home treatment of sick persons living in good
the inmates had been inoculated. The restrictions imposed on
3482.
remitted in the case of the once inoculated. Inoculations were co
week of September directly the City was declared infected. Am
themselves and their families inoculated were the majority of the
the Mysore Government. It was not, however, until the third w
the people came forward readily for inoculation. From the
23rd September 523, and between the 23rd and the 30th no less
were performed. By the 1st November 12,100 persons had been i
this time the supply of fluid from Mr. Haffkine's laboratory ran sho
from plague in the City continued to increase until the middle of Novem
had then already begun the enormous exodus of the population which, by th
3505.
December, reduced the numbers in the town from 84,000 to an estimated
25,034, *and* Weekly Statements relating to the course of the epidemic.
45,000. By the end of December, when the epidemic had practically ceas
persons had been inoculated, including 1,279 twice inoculated, but even after
had practically died out inoculations continued, and about 10,000 more pers
operated upon. No definite data can be obtained regarding the effects of the
tions, because no periodical census was taken, and the population was re
3251, 25,111.
we have seen, by nearly 50 per cent. The inoculated left the town in large n

and we have thus no knowledge of the actual numbers of the inoculated and uninoculated present in the town at different times during the course of the epidemic. Inasmuch as Para. 76 of this Report. we have seen that the recorded plague deaths in the City amounted to about two-fifths only of the presumptive number of such deaths, not much reliance can be placed on the figures which have been given as representing the incidence of the plague among the inoculated. Among the inoculated in Bangalore City 194 attacks were reported by the third week in December, but of these only 109 cases, of which 66 were fatal, were verified as actual plague cases among inoculates. The number of reported attacks 3516-20. among inoculates rose to 215 by the end of December, and to 233 by the 31st March; of these 139 and 158 respectively occurred in persons whose inoculation could be actually verified. Colonel Benson, I.M.S., Senior Surgeon and Sanitary Commissioner to the Mysore Government, stated that there may have been a very large number more of attacks and deaths among the inoculated than have been recorded, and that he was unable to say that either the number of attacks or the number of deaths was in any way complete. It was also pointed out that it was very difficult to ascertain, in the case 3522. of the large numbers of dead bodies thrown out into the streets, whether these had or had not been inoculated. Mr. Madhava Rao, the Plague Commissioner for the 3287. State of Mysore, stated that in some places he found that there had been attacks in inoculated persons which were concealed from the authorities. Such cases, he said, were never put on the register, in which therefore there must have been errors. There are thus no statistical results to be considered in connexion with the effect of inoculations in Bangalore City.

V.(6.)—*Bangalore City and Military Station.*

Inoculations in Bangalore Civil and Military Station.

444. As has been already stated, the plague spread from Bangalore City to the adjoining Civil and Military Station at the end of September 1898. The policy adopted in the Civil and Military Station was similar to that adopted in the City. The first case of plague occurred on 15th September, but the epidemic did not Paras. 74–5 of this Report. become really severe until the second week in October. On the 14th October, 11 persons died of plague, and the highest mortality was reached on 22nd November, when in one day 75 persons died of plague. From that time the epidemic gradually decreased, though it was still high in December when we reached Bangalore. In 25,034 *and* Weekly Statements relating to the course of the epidemic. February 1899 very few cases occurred, and the outbreak was practically over by the end of March. In the Civil and Military Station 1,075 persons, among the civil population, had been inoculated during the month of September; 12,378 had been inoculated by the 28th October; 20,591 by the 25th November; 27,419 by the 30th December; 29,928 by the 27th January 1899; 30,091 by the 24th February; and 31,794 by the 31st March. Of the ultimate total, 30,823 were single inoculations, and 971 double inoculations. The policy adopted towards inoculated persons was 2576–7, 2637. similar to that adopted in the City, and, as in the City, there was no proper periodical 2661–8. *census or* check upon the number of inoculated and uninoculated persons actually present in the Station from time to time, and the absolute necessity of accurate information on this point is obvious, in view of the large exodus which took place. 2639–41. With regard to the number of plague deaths, and also to the distribution of these among the inoculated and uninoculated, the information which is available is, as in the 3105. case of Bangalore City, very inaccurate. In many cases dead bodies were secretly 2593–4. buried or placed in the open, so as to prevent identification of the house in which 2604. death had occurred. In other cases bodies were found deserted in houses. These came to the notice of the medical men who were appointed to visit all cases of sickness that occurred and to find out particulars regarding all deaths. When asked concerning the correctness of the information that reached the authorities as to the number of deaths among the inoculated, Colonel Robertson, the Resident in Mysore, said, "I am 2645. not prepared to say that information would be reliable. . . . If a man has died, the municipal officer makes an attempt to get an inoculation certificate. He is supposed under the orders to get a certificate and send it to the inoculating officer. If there is any doubt as to whether the man has been inoculated or not, he sends it to the medical officer, who tries to trace it. The matter, however, is of great 2646. difficulty. I do not think the system is working well." Asked whether the people would readily give up the certificate of inoculation, the Resident replied, "I should 2647. think the tendency on the part of the deceased's relatives would be to stick to the certificate," and it follows that such a case would probably be classed as having occurred among the uninoculated. Captain Roe, R.E., who was in charge of plague measures in Bangalore, corroborated Colonel Robertson's opinion and said, "I think it is quite 2676. possible that these certificates may be passed on," and he admitted that there would be 2714–5. an undoubted inducement to retain them. The following table which refers in particular to cases certified to be plague by Government medical officers and unqualified native

25,037. medical practitioners between the 15th September 1898 and the 28th February 1899, has to be read in the light of the observations above quoted:—

—	Total number of Cases diagnosed as plague.		Number found to be inoculated.		Number found uninoculated.		Number doubtful or unknown.		Number of bodies buried without permit and counted as plague.
	Attacks.	Deaths.	Attacks.	Deaths.	Attacks.	Deaths.	Attacks.	Deaths.	
Seen by Government Medical Officers.	3,473	2,772	374	260	2,961	2,374	138	138	516
Seen by unqualified Native practitioners.	9	9	2	2	3	3	4	4	
Percentage of Total seen -	—	—	10·8	9·4	85·1	85·5	4·1	5·1	

In short, the figures with which we have been supplied regarding the civil population of the Civil and Military Station afford us no better basis for a correct estimate of the amount of protection conferred by inoculation upon the inoculated than do the figures which relate to the City of Bangalore.

Inoculations among the military population of Bangalore.
I. 114-5; I. 165-75.

III. 281-7.

Plague broke out among the Native troops of the Madras Army, the native followers of British Regiments, and the Transport and Commissariat followers stationed at Bangalore. We have been supplied with two sets of figures relating to the course of plague and the progress of inoculations among the military population affected. The first set of figures, put in by witnesses who appeared before us at Bangalore, carries us down to the 2nd December 1898 only, and will be considered later. The other set put in by Mr. Cadell covers the whole period during which there was plague in the Cantonments. Mr. Cadell's statistics supply us with details regarding each Regiment and body of followers among whom plague broke out, and are summarised by him in the two following statements:—

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Corps.	Strength.	Plague Seizures.				Plague Deaths.			
		Among uninoculated.	Among once inoculated.	Among twice inoculated.	Total.	Among uninoculated.	Among once inoculated.	Among twice inoculated.	Total.
		A.—FIGHTING MEN.							
Queen's Own Sappers and Miners.	769	2	9	—	11	2	4	—	6
2nd Madras Lancers -	554	3	12	—	15	2	7	—	9
1st Madras Pioneers -	797	1	—	2	3	1	—	2	3
17th Madras Infantry -	780	2	7	—	9	2	5	—	7
		B.—FOLLOWERS AND FAMILIES OF NATIVE TROOPS.							
Queen's Own Sappers and Miners.	1,651	6	9	—	15	4	3	—	7
2nd Madras Lancers -	1,298	7	15	1	23	5	10	1	16
1st Madras Pioneers -	786	—	5	1	6	—	—	1	1
17th Madras Infantry -	959	—	7	—	7	—	3	—	3
Commissariat and Transport.	1,272	5	10	—	15	3	6	—	9
Total A. and B. -	8,866	26	74	4	104	19	38	4	61
		C.—FOLLOWERS OF BRITISH TROOPS.							
4th Queen's Own Hussars	1,105	33	17	—	50	30	15	—	45
J. Battery, R.H.A. -	505	1	3	—	4	1	3	—	4
21st Field Battery, R.A.	595	3	11	—	14	3	9	—	12
25th Field Battery, R.A.	667	6	12	—	18	6	11	—	17
Total C. - -	2,872	43	43	—	86	40	38	—	78

III. 285.

Period.	Total of Native Troops and Followers.															
	Fighting Men.		Followers and Families.		Plague Attacks											
					Fighting Men.						Followers and Families.					
					Among uninoculated.		Among once inoculated.		Among twice inoculated.		Among uninoculated.		Among once inoculated.		Among twice inoculated.	
	Number once inoculated.	Number twice inoculated.	Number once inoculated.	Number twice inoculated.	Seizures.	Deaths.	Seizures.	Deaths.	Seizures.	Deaths.	Seizures.	Deaths.	Seizures.	Deaths.	Seizures.	Deaths.
Week ending 14th October 1898 -	637	–	328	–	–	–	–	–	–	–	–	–	–	–	–	–
„ 21st „ „ -	1,012	–	828	–	1	–	–	–	–	–	2	2	–	–	–	–
„ 28th „ „ -	1,728	–	2,603	–	6	6	–	–	–	–	14	12	2	1	–	–
„ 4th November „ -	2,548	–	6,553	–	1	1	4	3	–	–	4	3	11	10	–	–
„ 11th „ „ -	2,854	–	8,112	–	–	–	8	5	–	–	18	16	12	9	–	–
„ 18th „ „ -	2,839	28	8,403	38	–	–	2	–	–	–	9	9	20	13	–	–
„ 25th „ „ -	2,134	739	8,056	730	–	–	8	6	–	–	5	3	3	2	–	–
„ 2nd December 1898 -	1,476	1,401	7,769	1,062	–	–	3	1	1	1	1	–	5	4	–	–
„ 9th „ „ -	944	1,933	5,739	3,098	–	–	1	1	1	1	6	6	12	10	1	1
„ 16th „ „ -	691	2.209	5,508	3,330	–	–	1	–	–	–	2	1	14	9	–	–
„ 23rd „ „ -	678	2,222	5,421	3,417	–	–	–	–	–	–	–	–	2	1	1	1
„ 30th „ „ -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
„ 6th January 1899 -	–	–	–	–	–	–	1	–	–	–	–	–	3	–	–	–
„ 13th „ „ -	–	–	–	–	–	–	–	–	–	–	–	–	3	1	–	–
„ 20th „ „ -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
„ 27th „ „ -	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
„ 3rd February „ -	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
Total - - -	8,962	8,532	–	–	8	7	28	16	2	2	61	52	89	60	2	2

	Seizures.	Deaths.
Total among uninoculated - - -	69	59
„ „ once inoculated - - -	117	76
„ „ twice „ - - -	4	4
Total - - -	190	139

Criticism of figures regarding inoculations in military population of Bangalore.

The figures given above are summarised from detailed statements which set forth the the strength of the troops, the number of the followers as far as it was known, the numbers inoculated week by week from the commencement of inoculation to the date when plague ceased, and the numbers of attacks and deaths that occurred among the uninoculated, the once inoculated, and the twice inoculated respectively. Postponing for the moment the consideration of the accuracy of this statistical material, we may in the first place proceed to consider whether it is such as to be of use for the deduction of an estimate of the amount of protection which inoculation confers. We must therefore inquire whether, in addition to data with regard to the inoculated, the detailed statistics, which have been summarised above, supply us with data regarding the incidence of plague in uninoculated persons, whom we may justifiably compare with the inoculated soldiers and followers. Firstly, then, we must inquire whether there remained over in the separate military units any group of uninoculated persons who could serve as controls. Failing a control of the kind just mentioned, which would enable us to calculate the incidence of plague on the absolute number of inoculated and uninoculated, we must inquire whether we can obtain from the figures an average weekly strength of inoculated and uninoculated which we may justifiably use for the purpose of instituting the comparison which we have in view. Lastly, if we find that the statistics do not supply any figures on which we can base a comparison between the inoculated and uninoculated among the troops and followers themselves, we must inquire whether any of the facts with which we have been furnished with regard to the civil population of Bangalore supply us with the data for the required comparison. A scrutiny of the statistics of the military population reveals the fact that in each case the whole of the fighting men and of the followers who formed the communities under consideration were inoculated. There is thus no control group available in these communities themselves, in the sense in which control groups were present in the inoculation experiments in the Byculla Jail and at Undhera. Further, we cannot from the facts and figures regarding the civil population at Bangalore gather any idea as to what would have been the plague incidence among the military population if it had remained uninoculated. We have already pointed out that the number of

Paras. 432 and 438 of this Report.

the civil population is uncertain, that its distribution into inoculated and uninoculated is unknown, and that the record of attacks and deaths is incorrect. In order to determine whether we can find in the figures for the separate military units any material for a comparison between the average number of inoculated and the average number of uninoculated, during the period of the outbreak which elapsed between the commencement and end of inoculations, it will be convenient to II. 281-5. examine the data supplied us regarding the different bodies of troops and followers in the order given by Mr. Cadell in his detailed statistics. In the 2nd Madras Lancers, it appears possible to compare the incidence of plague on the average strength of the inoculated and uninoculated, among the troops from the 15th October to the 18th November, and among the followers from the 29th October to the 18th November. Before the dates given there was no plague among the troops and followers, and subsequently there were no uninoculated persons to be treated as controls. Among the Queen's Own Sappers and Miners, the only period in which a comparison seems possible, either among the men or the followers, is in the week ending on the 28th October, but it is doubtful whether conclusions of any value can be drawn from the figures of an isolated week. Previous to the week ending on the 28th October, there was no plague in the corps now in question, and afterwards all the troops and followers were inoculated in the interval which elapsed before plague reappeared. No deductions of any value can be made from the figures relating to the 1st Madras Pioneers. One case of plague occurred among the uninoculated men of this corps in the week ending on the 28th October, when the inoculated men were somewhat less in numbers than the uninoculated. No further cases occurred till the week ending on the 2nd December, by which time no men remained uninoculated. Among the followers no plague occurred till all had undergone inoculation. The figures for the 17th Madras Infantry up to the week ending on the 21st October relate to a period when there was no plague, but a comparison may be possible from the figures which relate to plague among the men from the 22nd October to the 25th November as cases then occurred while part of the regiment was still uninoculated. After the 25th November all the men were inoculated, and the followers did not get plague at all till practically all had undergone the process. The Commissariat and Transport followers, we find, had cases in the week ending on the 21st October, before inoculation began among them, and then no further cases till the week ending on the 2nd December, by which time all had been inoculated. If correct figures for the followers of the 4th Hussars were available, they would have afforded a very useful and interesting comparison between the inoculated and the uninoculated, as the number of attacks recorded among both classes was fairly considerable for some time after the inoculated reached their average strength; but as will be shown later on, the figures are not trustworthy, and therefore cannot be used to any good purpose. All the followers, both of J. Battery, R.H.A., and of the 21st Field Battery, had been inoculated before plague appeared among them. Among the followers of the 25th Field Battery, a comparison between the inoculated and uninoculated is possible for the period from the 29th October to the 25th November, but after that no uninoculated control remained.

Figures referring to followers incorrect and supply no basis for satisfactory comparison.

We have thus seen that a comparison could be instituted by making use of the figures relating to the men and followers of the 2nd Madras Lancers and of the Queen's Own Sappers and Miners, the men of the 17th Madras Infantry, and the followers of the 25th Field Battery; but when we proceed to inquire into the correctness of the figures we find that those relating to the followers cannot be accepted as accurate enough for our purpose. In one case the exact facts regarding the date of inoculation do not seem to be known. This is the case of the followers of the 4th Hussars. Inoculation I. 115, III. 283. was said to have commenced on the 31st October 1898, but the returns show two inoculated cases even before the 28th October, and Lieutenant Clements, R.A.M.C., 4622, 4626. informed us that he commenced the inoculations on the 26th of October and finished them in four or five days. In the case of the 21st Field Battery, Lieutenant Clements, 4630. R.A.M.C., said he had seen a re-inoculated person sick with plague on the 15th III. 284. December, but no re-inoculated person is set down in the returns as attacked. In several instances, cases among the uninoculated were reported to have occurred after it was supposed that the whole of the followers had been inoculated. Thus, the III. 283-6. 25,139. followers of the Commissariat and Transport were, it was supposed, all inoculated by the 25th November, but after that date three cases in uninoculated persons were reported among them. The reported strength of the followers of J. Battery, R.H.A., had been inoculated by the 4th November, yet one uninoculated follower is set down as having died from plague in the week ending on the 9th December. In the 21st Field Battery, the number of inoculated followers was equal to the supposed total number of followers by the 11th November, yet three cases among uninoculated followers occurred later. Similarly in the 25th Field Battery, where all followers are said to have been inoculated by the 25th November, four seizures and deaths among uninoculated followers nevertheless occurred between that date and the 9th December. Some idea of the amount of error that may exist can be formed from the case of the followers of the 4th Hussars. When he went to inoculate them, Lieutenant Clements was informed 4619-20. that they numbered 800, yet after he had operated on 1,068, he estimated that a balance of 50 still remained, and the number inoculated ultimately rose to 1,105 by the 25th November. It would appear that the people from the town were in the habit of coming into the lines of the followers to sleep, and may have been attacked and died there. Thus, as there can be no certainty about the number of the followers—which was in no case known exactly and may have been recorded with a considerable degree of error—it would be unprofitable to further deal with the figures for the followers of the 2nd Madras Lancers, the Queen's Own Sappers and Miners, and the 25th Field Battery, or to draw any conclusions from the figures for the followers as a whole.

Comparison between inoculated and uninoculated troops in different corps. 2832, III. 281-2.

In the case of the troops, however, though we may point out that their total strength as given by Colonel McGann and Mr. Cadell differs slightly, the figures given us may be accepted as fairly accurate and as, in a body of men who like these are under regular supervision, the facts regarding inoculation and attacks and deaths must have been correctly recorded, we may proceed to ascertain the results which we can gather from the figures regarding the men of the 2nd Madras Lancers, the Queen's Own Sappers and Miners, and the 17th Madras Infantry, for the periods which we have stated above to be those for which comparisons in these corps can be fairly made. These results may be summarised as follows:—

Corps.	Period.	Average Strength.		Attacks.		Percentage of Attacks.	
		Inoculated.	Uninoculated.	Inoculated.	Uninoculated.	Inoculated.	Uninoculated.
2nd Madras Lancers.	15th Oct. to 18th Nov.	426	128	9	3	2·1	2·3
Queen's Own Sappers and Miners.	Week ending 28th Oct.	749	20	0	2	0	10
17th Madras Infantry.	22nd Oct. to 25th Nov.	698	82	5	2	·7	2·4

The figures are so small and agree with each other so little, that they do not give us any trustworthy estimate of the protection afforded by inoculation.

Results among troops as a whole.

As then we have seen that the returns for individual regiments and bodies of followers are of little help to us for the purpose of making the comparison which we have in view, it seems necessary to summarise the results so as to ascertain what the average effect of inoculation was in the whole of the troops who were subjected to inoculation. We can take the figures for the troops after the week ending on the III. 285. 21st October, when plague appeared among them, and up to the week ending on the 9th December, when the whole of the troops had been inoculated and the disease practically died out among them, and, if we assume, as we think we may, that all the troops were throughout exposed to some risk of infection, then, inasmuch as the inoculations in the different corps were done at different times, we may treat the uninoculated men of the later inoculated corps as controls for the inoculated men of the earlier inoculated corps. If we take the strength of the troops present to have been 2,900, we find that between the dates named we get the following results:—

—	Average Strength.	Attacks.		Deaths.		Percentage of Case-Mortality.
		No.	Percentage.	No.	Percentage.	
Uninoculated - -	446	8	1·7	7	1·5	87·5
Inoculated - -	2,454	28	1·1	18	·7	62
Diminution of mortality in favour of inoculated - - - - -						·8

This is the only comparison which we think legitimate, and though it does not tell much in favour of inoculation as a means of warding off plague, we may point out that the vaccine was not severely tested on account of the efficiency with which sanitary

III. 287.

measures generally were applied to the military community. The results of another comparison have been placed before us by Mr. Cadell, in which the percentage of estimated deaths among the population of the Civil and Military Station is reckoned as 5·4, and is contrasted with a mortality of only 0·9 among a total military population of 15,183. But this cannot be accepted as even approximate, for while on the one hand Mr. Cadell's comparison is unduly to the disadvantage of inoculation so far as it fails to take account of the exodus from the Civil and Military Station which was not parallelled by any scattering of the military population, on the other hand it is unduly to the advantage of inoculation in that no allowance is made for the effects of the strict supervision of the military, the impossibility of the spread of infection from concealed cases, and the segregation and other sanitary measures which were effectively applied to them.

Statistics put forward by witnesses at Bangalore.
I. 114–5; I. 165–75.

We have postponed up to this point the consideration of the figures given to us by Colonel Esmond White, R.A.M.C., and other witnesses when we were at Bangalore, because we find that they afford us no help in arriving at a correct estimate of the advantages of inoculation. The comparison which is instituted in them is one based on average strengths, and the average strengths have been incorrectly taken as, in calculating them out, figures have been included which refer to a period antecedent to the outbreak of plague.

We have thus seen that, owing to the fact that all the soldiers of the Native Regiments affected in Bangalore were inoculated, and that all necessary sanitary measures were effectively applied to them on the outbreak of plague, results which can be deduced from the figures relating to inoculations among them are not so valuable as they might have otherwise been.

V.(7.)—*Mysore City.*

Inoculations in Mysore City.
Para. 79 of this Report.
Para. 84 of this Report.
25,034 *and* Weekly Statements relating to the course of the epidemic.

445. It will be convenient here to complete the consideration of inoculations in the Mysore State by dealing with the case of Mysore City, where also inoculations on a large scale were resorted to. We have already stated that though plague was imported into the City from Bangalore in October 1898, it did not become indigenous till the end of November, and was not severe till January 1899. To the end of June, 1899, as narrated in the historical portion of this Report, a number estimated to amount to about 3·5 per cent. out of 80,000, the normal population of the City, died of plague. The measures adopted to deal with the outbreak were much less stringent than those generally adopted elsewhere. They did not confer any material advantages upon the inoculated, except, perhaps, in the matter of facilities for railway travelling. Inoculations were performed in Mysore City under conditions more favourable for the production of the greatest possible advantage than in most places in India, for a very large number of persons were inoculated before plague become virulent. The number of people inoculated in October was 3,745; 6,926 more inoculations were done in November; and the number rose to 25,922 by the end of December. In January 1899, 3,149 inoculations were performed, and in February, though the climax of the outbreak was not reached till that month, less than 500 people submitted themselves for the operation. By the end of March the total number of inoculations amounted to 29,978.

Consideration of statistics for Mysore City.
24,977.
25,038.
25,034 (2).
Weekly Statements relating to the course of the epidemic.
25,040.

There was an exodus from Mysore, and a periodical census of the inoculated and uninoculated was not regularly taken from the commencement of the outbreak. Therefore, we have no means for the certain determination of the number of people present in the city from time to time, and their distribution among the inoculated and uninoculated. Moreover, the total recorded mortality exceeded the normal mortality by more than the recorded number of plague deaths, and the exact number of plague deaths, and their incidence on the inoculated and uninoculated parts of the population, is, therefore, unknown. In putting before us statistics regarding Mysore City, Mr. Cadell stated that the figures referring to attacks and deaths among the inoculated were ascertained by inquiries made in the households concerned, and that, if possible, a certificate was recovered, but it appears that out of 118 attacks assigned to the inoculated for the period up to the 28th February, 1899, only 98 attacks were verified as those of inoculates. Up to the end of March, out of 2,076 reported plague deaths, about 111 only are said to have occurred among the inoculated portion of the community. Only 158 inoculated persons are reported to have been attacked. *Primâ facie* it is not likely that, in Mysore, relatives or others would represent a dead man to have been inoculated when he was not so, and the medical officers stated that they only found rare instances in which transference of certificates was suspected. But, on the other hand, there was nothing to induce people to report plague, inasmuch as omissions to report usually passed undetected and unpunished. Therefore we cannot assume that the number of reported cases correctly represents the number of cases that actually occurred. Moreover, in consideration of the large proportion of the population which was inoculated, and the fact that the numbers of inoculated must have lived in close connection with plague in their houses, we cannot believe that the number of attacks and deaths attributed to the inoculated actually represents the number that occurred. Indeed, Mr. Cadell in putting the figures before us, pointed out that they were inaccurate. He said with regard to these figures: "I have put them 25,037. here for what they are worth, but from Mysore City they are inaccurate as far as regards the examination of the bodies, and I would not vouch for them." Nevertheless, 25,112-5. Mr. Cadell believed that there was no great number of hidden cases and deaths among the inoculated, though he thinks that a certain number of people did get inoculated in 25,108. order to get away, as facilities for travel were given to the inoculated.

We have, therefore, no data for any calculation, even approximate, of the effects of inoculation in Mysore City, and any attempt at such a calculation would fail. But we do not doubt that inoculations did much good in the City.

V.(8.)—*Karachi City.*

Inoculations in Karachi City.

446. The most elaborate attempts to collect statistics regarding inoculations, in places other than those we have already dealt with, were made in Karachi, Bulsar, and Baroda, and we will now proceed to consider the figures laid before us for these places in the order given.

With reference to inoculations in Karachi we have to consider only the second outbreak of plague in the City. When this outbreak commenced in March 1898, II. 423. Mr. Kaka, the Health Officer to the Municipality, suggested that inoculation should be introduced. On the 13th April he commenced to inoculate those who offered themselves. The Plague Committee, however, did not at once take up the matter, and it was not till the 2nd of May that they resolved to encourage inoculation by relaxing the ordinary plague measures in favour of the inoculated. The privileges that the Committee resolved to grant to the inoculated were not great, and consisted in permitting once-inoculated contacts to go to health camps instead of to segregation camps, provided that they had been inoculated at least four days before the occurrence of the case on account of which, if uninoculated, they would have been segregated. No additional privileges were accorded to the twice-inoculated. The privileges that were accorded were not sufficient to induce many people to come forward for inoculation, and manifestly, there was no inducement to undergo double inoculation. Up to the 19th July, when inoculation ceased because the outbreak was well on the decline, only 6,106 persons had undergone inoculation; only 287 of these had been inoculated twice. Of the total of 6,106 about one-third were Khojas, who will be particularly dealt with later on, and who had special reasons for being inoculated.

Statistics for Karachi City.

The materials contained in the evidence of Mr. Kaka, and in his report on the Karachi inoculations which we have before us, provide us with information regarding the progress of the inoculations and the occurrence of plague among inoculated persons. This information may be tabulated as follows:—

II. 423, 426.

Week ending	Number of inoculations performed among			Occurrences of Plague among inoculated.		Remarks.
	Residents of Karachi other than Punjabhai Khojas.	Punjabhai Khojas.	Total.	Cases.	Deaths.	
April 15th, 1898 -	19	—	19	—	—	The second outbreak in Karachi reached its climax in the beginning of May and declined to small proportions in July, with a continuation of cases in small numbers in the succeeding months.
" 22nd " -	25	—	25	—	—	
" 29th " -	108	16	124	—	—	
May 6th " -	295	616	911	—	—	
" 13th " -	555	690	1,245	6	2	
" 20th " -	667	304	971	11	5	
" 27th " -	857	137	994	2	3	
June 3rd " -	411	46	457	7	4	
" 10th " -	580	51	631	1	2	
" 17th " -	360	29	389	5	—	
" 24th " -	188	2	190	2	1	
July 1st " -	62	7	69	1	—	
" 8th " -	23	—	23	—	—	
" 15th " -	41	—	41	—	—	
" 22nd " -	17	—	17	4	2	
" 29th " -	—	—	—	2	1	
August 5th " -	—	—	—	2	4	
" 12th " -	—	—	—	1	1	
October 21st " -	—	—	—	—	3	
Total - -	4,208	1,898	6,106	44	28	

NOTE.—Mr. Kaka has counted among the uninoculated the three cases which occurred in the week ending on 21st October 11,760-3. as the patients were attacked more than five months after inoculation, and as he was of opinion that inoculation did not protect for more than five months. This opinion he founded upon the dictum of a newspaper.

Criticism of figures for Karachi City.
11,765; II. 424-5.
11,374, 11,713-7, 11,756, 11,804.

Mr. Kaka, in summing up his remarks on the subject of inoculations in Karachi as a whole, states that the figures show a difference of 84 per cent. in plague mortality in favour of the inoculated, but he himself says: "These results must be accepted with reservation, as the actual population of Karachi during the plague is not accurately known." Not only was the population not accurately known, but Mr. Kaka's estimates may have been very wide of the mark. No attempt was made to determine the respective numbers of those who remained in the City and those who left for the camps outside. Neither in the City nor in the camps outside was any census taken to ascertain the respective numbers of the inoculated and the uninoculated. Inasmuch as both classes left the City, the basis of Mr. Kaka's calculations with respect to the relative incidence of plague among the uninoculated and inoculated must be wrong, inasmuch as he made a deduction from the uninoculated on account of persons who left the City, while he made no such deduction in the case of the inoculated. A further error has been admitted into Mr. Kaka's calculations, inasmuch as he omitted to notice that the incidence of plague among the inoculated and the uninoculated respectively ought to have been calculated on their average strength, and not, as he has calculated it, on the respective total numbers of those who were inoculated and uninoculated at the end of his period of observation. In the particular case of Karachi, the error which must thus have been imported into the calculations is very considerable, inasmuch as only 2,324 of the 6,106 inoculations were done before the middle of May, when the outbreak had begun to decline.

For the above reasons it will be apparent that no good purpose can be served by a detailed consideration of the figures relating to the City as a whole. We may, therefore, turn to the consideration of certain further statistics which are included in the totals for the City, and relate to narrower spheres of observation. We have been furnished with two sets of statistics, one relating to the Khoja community, and the other to a group of inoculated and uninoculated persons living in a number of plague-infected houses in the City.

Inoculations among the Khojas of Karachi.
II. 426-7, 11,718.

In dealing first with the figures relating to the Khojas, it must be pointed out that Khoja community of Karachi is divided into two sects, the Pirai and the Punjabhai Khojas who lived chiefly in the badly affected Machi Miani quarter, and were not like the other inhabitants of the quarter evacuated from their houses. The Pirai Khojas, who are not followers of H.H. the Aga Khan, were practically uninoculated; of 245 members, 4 only were inoculated. On the other hand, the Punjabhai Khojas, like their co-religionists in Bombay, resorted to inoculation, in accordance with the recommendations and directions of H.H. the Aga Khan, who is recognised as a spiritual leader by this sect. Under the Aga Khan's encouragement, it is not surprising to find that 81 per cent. of the Punjabhais were inoculated.

Statistics regarding Punjabhai Khojas and method of compilation.
II. 426-7.
11,720.

The statistics at our disposal, which relate to the Punjabhai Khojas, fix the number of the community at 2,326. This estimate is based upon a census taken by the Khojas in August 1898, at a time when they had ceased to suffer from plague. Mr. Kaka has checked the accuracy of the census by calculating out the numbers of the community on the number of deaths recorded among them in ordinary years, taking as the basis of his calculation the assumption that their average rate of mortality was similar to that of the City of Karachi as a whole. Mr. Kaka comes to the conclusion that the census is approximately correct, and we see no reason for doubting the correctness of his conclusion. Mr. Kaka computed the number of Khojas present at the beginning of the outbreak by adding, to the number found present at the census, a number corresponding to the number of reported plague deaths. Having obtained the initial population in this manner, he obtained his number of inoculated by going through his registers and totalling up the number of persons who had undergone inoculation during the whole period of the outbreak. He arrived at the number for the uninoculated by deducting from the assumed initial population the total number of inoculated persons. The total strength of the Khojas during the second outbreak of plague in Karachi was thus computed to consist of 1,898 inoculated and 428 uninoculated persons. These figures are not absolutely correct, because in estimating the initial population no allowance was made for deaths from general causes. We have, however, satisfied ourselves that the error which has been introduced into the statistics by leaving out of consideration the deaths from general causes does not materially affect the results.

13,227-39.

It is apparent that for his data regarding plague cases and deaths and for their distribution between the inoculated and uninoculated, Mr. Kaka has relied principally upon a comparison of the names of persons reported by the plague officers to have suffered from plague, with the names recorded in the inoculation registers. He states, however, that he attempted to supplement the information which he thus obtained by private inquiries. He says :—" I took the Headman of these Punjabhai Khojas into my confidence. I put a special man of my own in charge. He knows all these houses where the Khojas are, and he went round from house to house and enumerated them." We cannot lose sight of the possibility that the information thus obtained may have been insufficient or inaccurate information, but Mr. Kaka himself claims that in so far as they relate to the inoculated, at least, his statistics are quite correct. 13,233.

Mr. Kaka's estimate of protection afforded not based on average strength ; results of calculation on that basis.
II. 427.

On the basis of the information thus obtained, Mr. Kaka institutes a comparison between the plague incidence among the inoculated and that among the uninoculated respectively, and arrives at the conclusion that there was " a difference of 77 per cent." in plague mortality in favour of the inoculated.

We cannot accept this estimate, because, since the numbers of the inoculated and uninoculated were constantly altering, the incidence of plague ought, we think, to be calculated upon their respective average strengths. The statement of the progress of inoculation which was supplied to us by Mr. Kaka allows us to ascertain the average strength of the inoculated, and, from this, we are able to obtain an approximate estimate of the average strength of the uninoculated by deducting the average of the inoculated from the total estimated population, which, as we have already stated, can be accepted as sufficiently accurate for this purpose.

We find that the large majority (1,809) of the total inoculations (1,898) was done between the 25th April and the 3rd June. This interval corresponds with the period during which plague was most severe in the City, and also to that in which all the recorded cases among the Punjabhai Khojas occurred. We, therefore, cannot go wrong if we limit our consideration to that part of the statistics which relates to the six weeks between the 23rd April and the 3rd of June. We may work out a comparison for the period in question as follows :—

—	Average Strength.	Reported Plague Deaths.	
		Number.	Percentage.
Uninoculated - -	1,132	28	2·4
Inoculated - -	1,149	9	·75
Diminution of mortality due to inoculation	-	- -	1·6

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It is to be noted that the comparison given above holds true only if the inoculated and uninoculated are comparable communities, and if the deaths are correctly distributed among the inoculated and uninoculated and between plague and general causes. We now proceed to consider these points.

Question of comparability of inoculated and uninoculated Khojas at Karachi.

The figures which Mr. Kaka has given us, of the deaths recorded in the Khoja community from causes other than plague, supply us with a means of determining whether, from the point of view of general health, the inoculated and uninoculated are comparable. We propose to set forth the data, first, for the period in which inoculations were in progress and the community suffered from plague ; secondly, for the period from the 1st July to the 30th September ; and, thirdly, for the additional period from the 1st October to 21st January 1899, for which Mr. Kaka prepared figures at our request and after his examination. 11,740 ; 11,780. For the first period we can base our calculations on the average strength of the inoculated and uninoculated deduced from the figures in Mr. Kaka's report ; for the last two periods, the only basis of calculation which is available are the figures of the inoculated and uninoculated respectively, as determined in the census made in the month of August. In making use of the census figures we have abstained from any attempt to apply corrections for exodus or for deaths from general causes, for, as we have already explained, we give these figures only as approximately correct. The data for each of the periods may be summarised as follows:—

11,740.

11,780.

Period.	Number of Inoculated.	Number of Un-inoculated.	Deaths from General Causes among Inoculated. Total. No. of Deaths.	Inoculated. Total. Rate per Mille per Annum.	Inoculated. Children under 5 (amounting to 8·9 per cent. of Total Inoculated). No. of Deaths.	Inoculated. Children under 5. Rate per Mille per Annum.	Uninoculated. Total. No. of Deaths.	Uninoculated. Total. Rate per Mille per Annum.	Uninoculated. Children under 5 (amounting to 24·7 per cent. of Total Uninoculated). No. of Deaths.	Uninoculated. Children under 5. Rate per Mille per Annum, calculated upon the total strength of the uninoculated.
	Average	Strength.								
23 April 1898 to 30 June (Period of plague) 10 weeks	1,470	856	0	0	0	0	27	163	10	60
	Absolute	Strength.								
1 July to 30 Sept. 13 weeks -	1,898	428	0	0	0	0	15	140	11	106
1 Oct. to 21 Jan. 1899 16 weeks -	1,898	428	2	·5	0	0	3	22	2	15
Number and rate per mille per annum of deaths recorded in 39 weeks -			2	1·1	0	0	45	112	23	57

The results tabulated above are so remarkable, indicating as they do such an extraordinary difference in respect of general health between the inoculated and the uninoculated, that attempts have been made in various ways to account for the differences in the mortality of the two groups.

Excess of deaths in uninoculated not due to children.

It has been confidently suggested that the excessive number of deaths from general causes among the uninoculated must have been due to the excess of deaths among children, who formed a larger proportion of the uninoculated community than of the inoculated community. With a view of testing this suggestion, we have worked out from the data which have been supplied to us, the rate of mortality from general causes which deaths among children under five give upon the total strength of the uninoculated, and we have included the results in the table given above. It is shown by the table that no death occurred in 39 weeks among children under five
11,734. who were inoculated (these amounted to 168), while in the same period uninoculated children of similar age (these numbered 106) lost by deaths from general causes 23, or one-fifth of their number. It is also clear that, after deducting the percentage of deaths from general causes in children, there still remains to be accounted for an extraordinary difference in mortality from general causes between the inoculated and the uninoculated. Excluding the children, we find that during the period of plague, the inoculated had not a single death from general causes, while the uninoculated suffered at the rate of 103 deaths per mille per annum, and that during the 39 weeks for which we have figures, the inoculated died at the rate of 1·1 only per mille per annum, while the death-rate among the uninoculated was 55 per mille per annum.

Excess of mortality in uninoculated not explained by wrong assignment of plague deaths to general causes.

We must, therefore, look further for an explanation. Consideration shows that we should have an explanation of the excessive mortality among the uninoculated if we assumed that deaths have been wrongly attributed to general causes which in reality are due to plague. That this might have been so is evident from the fact that the causes of death were, at least in some cases, set down on no other evidence than the statement of the relatives of the deceased. Verification by corpse inspection
13,259. was not always made. Moreover, the suggestion that a large number of plague deaths may have been assigned among the uninoculated to general causes, might be supported by the figures given in the table above, which show that the period when the largest number of deaths from general causes was assigned to the uninoculated is the period in which plague cases were occurring among the Khojas. On the other hand, this suggestion would appear to be inconsistent with the fact that the numbers set down for the mortality from general causes among the uninoculated remained

abnormally high during the succeeding period up to the 21st January. In the 29 weeks beginning from the 1st July, the death-rate according to the figures of the mortality from general causes assigned to the uninoculated is equivalent to an annual death-rate among them of 76 per mille. Therefore, this suggestion does not explain the above normally high mortality among the uninoculated. Moreover, it leaves unexplained the extraordinary absence of mortality from general causes among the inoculated.

We cannot believe that, in a community, like that of the inoculated, whose average strength was nearly 1,800, and which included among it 168 children under five and 73 persons of 60 years of age and upwards, there can have been no deaths from general causes during a period of 33 weeks, and that only two deaths occurred in the whole period of 39 weeks covered by the statistics supplied to us. We can see no way out of the difficulty except in assuming that a certain number of deaths which are set down as having occurred among the uninoculated ought in reality to have been assigned to the inoculated. This conclusion wins support from the fact that the total number of deaths which are assigned to general causes, set down as having occurred among the Khojas during the whole period of observation, would, if calculated upon the total number of the members of the community, both inoculated and uninoculated, give us a death-rate from general causes of about 28 per mille per annum, which, allowing for exodus and other causes of error, is an approximately normal death-rate such as we might have expected to have occurred.

Wrong assignment to uninoculated of deaths in inoculated only explanation of excess of general causes mortality in uninoculated.
11,752–7.

We see no alternative to accepting this explanation, that deaths which occurred among the inoculated were erroneously assigned to the uninoculated, unless we can here fall back upon the suggestion which we have already dealt with in considering the case of the Khojas of Bombay, that anti-plague inoculation affords protection not only against plague but also against other diseases. We are unable to accept this suggestion as an explanation of the statistical data which we are considering, for we could not explain these data in accordance with this suggestion unless we assumed that the plague prophylactic conferred an even greater protection against diseases in general than that which it confers against plague.

Explanation that inoculation protects against diseases other than plague must be rejected.

Para. 436 of this Report.
11,746.

On a consideration of all the circumstances, therefore, our conclusion is that the statistics compiled by Mr. Kaka cannot be accepted as giving even an approximately correct indication of the course of plague and the results of inoculation among the members of the Punjabhai branch of the Khoja community in Karachi, and it is not improbable that the statistics relating to this community have been seriously vitiated on account of the existence of some such tendency in Karachi, as that which we indicated to have been in operation among the Khojas in Bombay, to do more than justice to inoculation. At any rate, the statistics are so untrustworthy that they are useless for the purposes of accurate scientific deductions.

Accurate deductions impossible from statistics of Khojas in Karachi.

We have now to consider a group of figures which relates to the effect of inoculation in 56 plague-infected houses. The particulars concerning these have been collected by Mr. Kaka and put before us in the form of investigation sheets. These investigation sheets will be found in the appendix to Mr. Kaka's report on inoculation. Before proceeding to consider whether any deductions can be based on these, it is necessary to note a few points regarding them which have attracted our attention and which we think indicate that success has not been attained in collecting, for all the houses in question, all the data which are essential to enable us to arrive at a correct judgment as to the incidence of plague among the inoculated and the uninoculated. We notice, for instance, that in the case of one house—that to which the investigation sheet bearing the number 38 in Mr. Kaka's appendix refers—the only residents of the house would appear to have been a girl of eight years of age who died of plague and a boy of five years of age. It is obvious that there must have been other people in this house, and, indeed, we learn from a note on the investigation sheet that there was, at least, their mother in the house with the two children. The investigation sheets numbered 2, 11, 15, 16 and 24 give us to understand that in each of the houses in question there was only one resident. In one case the sole resident was a young woman. In view of our knowledge of the customs of the natives of India, with regard to family life and the coverture of women, we think it probable that these statements cannot be taken as accurately representing the condition of things in these houses. Moreover, we find that in the case of each of these houses the resident who appears

Mr. Kaka's investigation sheets.
II. 428–42.

in the records was an inoculated person who died. We think that we may from this fact infer that Mr. Kaka's investigation sheets were, in the first instance, compiled by checking from the register of inoculation the names of those who were reported to have been attacked or to have died of plague. We do not doubt that Mr. Kaka then proceeded to verify and complete the data thus obtained by actual visits to the houses concerned. But we think that, at the time of the inquiry, the rest of the inhabitants—and this relates in particular to the uninoculated inhabitants who were liable to be segregated—may very probably in many cases have run away, so that it was impossible to ascertain how many people had really lived in each house, and whether other cases of plague had or had not taken place there. Mr. Kaka himself, in the case of one or two houses, adds a note to the effect that full particulars could not be ascertained. Further, we find on going over the investigation sheets that, although there are six houses in which more than one case is recorded among the inoculated, there is no house in which more than one case is recorded as having occurred among the uninoculated. This can, we think, be explained only on the assumption that the uninoculated left their houses directly after plague appeared in them.

Investigation Sheets, Nos. 38 and 90.

Mr. Kaka's investigation sheets appear to us to have little value; first, because as has been shown above, we have reason to believe that they are not complete records, and, secondly, because the inoculated and uninoculated were not living under comparable conditions, inasmuch as the former remained in the infected houses, while the latter were removed from them as soon as a plague case occurred. Nevertheless, it will be of interest to summarise the data which are set down by Mr. Kaka. If we take into consideration the facts which are recorded regarding the whole of the 56 houses mentioned in Mr. Kaka's appendix, the results are as follows:—

—	No.	Attacks.		Deaths.		Case Mortality per cent.
		No.	Per cent.	No.	Per cent.	
Uninoculated -	76	17	22·5	12	15·7	70
Inoculated - -	285	47	16·7	25	8·9	53
Diminution of mortality due to inoculation	-	-	-	-	6·8	

If, on the other hand, we exclude 21 houses in which plague cases occurred only among the inoculated, and in which there is no record of the presence of uninoculated residents, we shall, on account of the elimination of houses in which there are no uninoculated controls, obtain from such materials as Mr. Kaka has furnished results which will have somewhat greater objective value. The comparison thus instituted will then read as follows:—

—	No.	Attacks.		Deaths.		Case Mortality per cent.
		No.	Per cent.	No.	Per cent.	
Uninoculated - -	76	17	22·5	12	15·7	70
Inoculated - -	213	23	10·6	11	5·1	45
Diminution of mortality due to inoculation	-	-	-	-	10·6	

V.(9.)—*The Town of Bulsar.*

Inoculations at Bulsar
16,256.
16,291.

447. Inoculations were introduced into Bulsar, a town in the neighbourhood of Surat, in the early part of 1898. They were limited in their application to four wards of the town. Considerable inducements were offered to encourage inoculations, inasmuch as, in contrast with what was done in the case of the uninoculated, the inoculated were not segregated and were allowed at first to treat their sick in their own houses, and afterwards in special houses set apart in their quarters. Out of a total population of 1,190 in the four quarters concerned 1,018 were inoculated. The

results of the inoculations are set forth in the following table compiled from particulars given to us by Assistant Surgeon Dadachanji, who did the inoculations:—

Quarter.	Population taken into account.	Number inoculated.	Number uninoculated.	Percentage of plague attacks among		Percentage of plague deaths among		Case mortality (deaths to attacks) among	
				Inoculated.	Uninoculated.	Inoculated.	Uninoculated.	Inoculated.	Uninoculated.
Dheberwad -	180	170	10	2·4	0	0·6	0	1 in 4	0 in 0
Taiwad -	499	490	9	13·3	44·4	4·7	22·2	23 in 65	2 in 4
Machiwad -	105	97	8	8·2	12·5	3·1	12·5	3 in 8	1 in 1
Ghanchiwad	296	261	35	2·7	11·4	1·5	11·4	4 in 7	4 in 4
Total -	1,080	1,018	62	8·2	14·5	3·0	11·3	31 in 84	7 in 9

16,256.

It is to be noted that the plague occurrences entered in this table all occurred after the completion of inoculations. It is further to be noted that the population under observation does not include the whole of the population of the wards. Mr. Dadachanji has in his figures for the population under observation left out of account 110 people out of the total population of the four wards, as 62 of these were children under two, 30 had had plague during a previous outbreak, and 18 were attacked by plague in the outbreak under consideration before inoculations were completed. Lastly it is to be noted that the number of uninoculated persons who came under observation amounted to no more than 62. This number is so small that we may assume that it consisted in large part of persons who remained uninoculated because they were unfit for inoculation. The mortality among these might naturally be expected to be higher than in a normal community. As a matter of fact, we find that from May to December 1898, the 62 uninoculated lost 8 persons on account of deaths from general causes, while the 1,018 inoculated lost 10.

16,259.
II 320.
II. 320.

As far as we have been able to judge, Mr. Dadachanji's figures have been carefully collected. A census of the town was taken at the end of 1897, and a complete census of the inoculated wards was taken again at the time of inoculations. A list of the inoculated and uninoculated inhabitants was posted up on the door of each house, and each house is said to have been visited daily by a medical officer who had orders to satisfy himself regarding every person living in it, and to call out the inhabitants daily for inspection. In this manner the number of plague cases and deaths, and their distribution between the inoculated and the uninoculated, were ascertained.

16,288.
16,298–306.

It will be seen from the table that the effect of anti-plague inoculation manifested itself here especially in the reduction of case mortality. When we take into consideration the fact that the uninoculated were a sickly community, we see that it is probable that inoculation exerted little, if any, effect in warding off plague attacks.

Comparisons between inoculated and uninoculated wards in Bulsar.

In addition to the comparison which has been set forth above between inoculated and uninoculated persons living in the same wards, we have, in Bulsar, in two instances data for comparing the course of plague in a ward which was almost completely inoculated "with the object," as Mr. Haffkine told us, "of seeing to what extent plague could be arrested by that," with the course of plague in a similar ward to which inoculations were not applied. The wards in question are two wards inhabited by Ghanchis, and two wards inhabited by Tais. In each case, in order to obtain the total population of the inoculated wards for comparison with the total population of the uninoculated wards, we may add together, in the case of the former, the whole of the inoculated and uninoculated residents.

75.
16,280, 16,287.

Two Ghanchi wards in Bulsar.

We may consider first the case of the two Ghanchi wards. Our information concerning these was obtained from Mr. Dadachanji. The following table shows the incidence of plague among the Ghanchis in the inoculated and the uninoculated wards respectively:—

16,287.

Ward.		Population.	Plague Cases.		Plague Deaths.	
			Number.	Percentage on population.	Number.	Percentage on population.
Ghanchis	Uninoculated Ward -	154	23	14·9	16	10·4
	Inoculated Ward -	296	11	3·7	8	2·7

We have no details which will enable us to arrive at a judgment as to how far the two Ghanchi wards contained comparable communities. None the less, it is worthy of note that the above table shows a diminution in plague attacks of about 11 per cent. and in plague deaths of about 8 per cent. in favour of the inoculated ward. This estimate is based upon the census population of the two wards. We were, however, 16,287-91. told by M. Dadachanji that there was a considerable exodus from the uninoculated ward and that at least half the population left; on the other hand, it is said that no similar exodus occurred from the inoculated ward. In view of this, the advantage in favour of the inoculated ward would be practically double that which is set forth in the table.

Two Tai wards in Bulsar.

16,280-1.
19,970-94.

The next case we have to consider, is that of the two Tai wards. The information at our disposal as to the inoculated Tai ward is derived from Mr. Dadachanji's evidence; the data relative to the uninoculated Tai ward were supplied by Major T. E. Dyson, I.M.S., who was in the Surat district in 1897 and 1898. We were assured by Major Dyson that the two wards were absolutely comparable. On the other hand, it would appear that both wards did not suffer from plague at one and the same time, so that the figures of the two wards may relate to outbreaks of different severity. A comparison, however, can be made as follows:—

	Ward.	Population.	Plague Cases.		Plague Deaths.	
			Number.	Percentage on population.	Number.	Percentage on population.
19,991.	Tais - Uninoculated Ward -	492	65	13·2	47	9·5
16,281.	Tais - Inoculated Ward -	490	65	13	23	4·6

In spite of the fact that the prophylactic fluid was operative in reducing plague mortality by about 5 per cent., it appears that it did not sensibly reduce liability to attack by plague.

V.(10.)—*Baroda State.*

Inoculations in the Baroda State.

App. LII. in Vol. II. of these Proceedings.

Para. 438 of this Report.

448. In the State of Baroda inoculations were introduced into a number of villages. Our information with regard to them is drawn from data supplied by Mr. Mehta, who was the medical officer in charge of plague operations in the State. This information is contained in Mr. Mehta's evidence and in a report which is published as an Appendix to our Proceedings. In 13 of the 31 villages into which inoculation was introduced there was no plague after inoculation. In them we have no materials for a determination of the effects of inoculation on plague. In 18 villages, cases of plague did occur after the inoculations. One of these villages was Undhera, where Mr. Haffkine personally superintended the inoculations, the results of which have already been considered in this Report. Excluding Undhera, there remain only 17 villages which come into consideration here. With a view to testing the accuracy of the figures which have been supplied to us with regard to the course of plague in these villages, we propose to consider only the figures which relate to the six villages in which plague cases occurred among both the inoculated and the uninoculated. The figures relating to these six villages may be collected together as follows:—

Village.	Total.	Population.		Total Plague Cases.	Total Plague Deaths.	Plague Cases after Commencement of Inoculations among.	
		App. R. II. 517.				App. R. II. 517.	
		Uninoculated.	Inoculated.	App. U. II. 519.		Uninoculated.	Inoculated.
Savali - -	6,551	6,535	16	446	321	465	4
Billimora - -	5,350	4,918	432	277	217	228	26
Koili - - -	3,221	2,162	1,159	144	129	123	13
Jarod - - -	2,137	2,057	80	61	44	24	2
Bajwa - -	609	453	156	47	37	34	5
Kantharia - -	364	254	110	22	22	4	2

Mr. Mehta has, after adding in the figures which relate to the village of Undhera, summed up the results of inoculation which are tabulated above as follows; "The II. 503. number of attacks per mille of population is 24·3 in inoculated, against 53·8 in the others, and of deaths, 55·4* against 46·9.* The results of Undhera, Koili, and

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* We presume these figures have been inadvertently transposed by Mr. Mehta.

Bajwa are very good, and of Billimora and Kantharia very fair. The effect in case mortality at Savali is also fairly good."

Criticism of statistics of villages in Baroda.

Before we can accept Mr. Mehta's conclusions we must check against each other the figures given by Mr. Mehta in the various tables with which he has supplied us, and further we must check Mr. Mehta's figures by comparing them with figures given by other witnesses. It will suffice to notice a few of the points which have arrested our attention in applying these checks. First then as to the total population. In the case of Billimora we find that Mr. Mehta, on pp. 263, 265, 504, 517, and 520 of the Second Volume of our Proceedings, has given five different estimates of the population which vary from 5,215 to 5,577. Further there are differences in the estimates of population furnished by Mr. Mehta and those furnished by other witnesses in the cases of Koili and Bajwa. Dewan Bahadur V. M. Samarth, Subah of the Baroda II. 496-7. Division, and Mr. Shamsuddin J. Sulemani, the Chief Medical Officer of the State, stated that the population of Koili and Bajwa was 3,695 and 703 respectively, instead 14,794. of 3,321 and 609, the figures given by Mr. Mehta. With regard to plague cases we may notice in the first place that Mr. Mehta is in conflict with himself in respect of the figures he gives for Savali. It will be seen that he gives the total number of plague cases during the epidemic as 446, whereas he gives the number that occurred after inoculation as 469. Similarly he is conflict with himself in respect of the number of plague cases that occurred after the introduction of inoculations in Billimora; in one statement he gives the gives the number as 254 and in another as 156. II. 509 (A. 1). Dewan Bahadur Samarth has given us the number of plague attacks that occurred in II. 517 (R.). each of the villages entered in the table above, excepting Billimora. His figures in every instance disagree with those given us by Mr. Mehta. Thus Mr. Mehta's totals of plague attacks for Savali, Jarod, and Kantharia are 446, 61 and 22 respectively, while the totals of attacks in these villages according to Dewan Bahadur Samarth's II. 501, 500, 498. figures are 507, 24 and 15 respectively. Moreover, Mr. Shamsuddin J. Sulemani gives us the number of attacks in Koili and Bajwa, and in the case of the former village 14,794. he states that there were 117 attacks, in this differing from both Mr. Mehta and Dewan Bahadur Samarth, though in the case of Bajwa, his figures agree with those of Mr. Mehta.

After these criticisms it is obvious that we shall not be able upon Mr. Mehta's general statistics to base any accurate estimate of the amount of protection conferred by Mr. Haffkine's inoculation throughout the State of Baroda or in any particular Baroda village considered as a whole.

Mr. Mehta's investigation sheets.

We have, however, further to consider certain statistics which Mr. Mehta has prepared and which deal with the incidence of plague in particular groups of infected houses situated in certain of the villages of the State. The data which are furnished regarding these are in the form of a synopsis of investigation sheets for each of the three villages of Billimora, Koili, and Kantharia. They may be tabulated as follows:—

Village.	Number of houses to which data apply.	Number of inoculated.	Number of uninoculated.	Percentage of attacks among		Percentage of deaths among		Percentage of case mortality among		
				Inoculated.	Uninoculated.	Inoculated.	Uninoculated.	Inoculated.	Uninoculated.	
				Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
Billimora - -	64	105	249	25	30·4	15·2	24·8	60·6	81·7	14,848.
Koili - -	26	48	73	27	24·7	18·8	23·3	69·4	94·5	14,937.
Kantharia - -	3	4	14	50	28·6	50·0	28·6	100·0	100·0	II. 506.
Total - -	93	157	336	26	29·4	17·2	28·0	66·0	95·0	

We have not been supplied with any materials for effectively criticising these investigation sheets, for we have not been informed how they were originally prepared, how the numbers of the inoculated and the uninoculated in the various houses were ascertained, and what steps were taken to secure that entries were properly made. We 15,040–54. learned however that the facts set down on record were not always elicited by personal inquiry, and our general impression is that the inoculation sheets were not actually prepared on the spot and therefore cannot be trustworthy. Nevertheless we may note two points regarding the results set down. The first of these is that the inoculated residents of the plague-infected houses under investigation appear to be have been almost as liable to attack as their uninoculated fellows. The second point is that, inasmuch as inoculation considerably reduced the severity of attacks, there was a dimunition of mortality amounting to 11 per cent. in the number of the inoculated, as compared with the uninoculated.

Inoculations in Baroda City.

The figures which have been supplied to us regarding inoculations in the City of Baroda afford us no help in coming to a conclusion as to the value of inoculations in general. Two thousand seven hundred and twenty-five people in all were inoculated in the City. Of these 2,146 were residents of the City, which has a population of 112,471; the balance of 579 inoculated persons consisted of prisoners. (14,988.) These prisoners may be left out of account, inasmuch as there was no case of plague in the Jail or anywhere near it. As to the other persons inoculated, it is to be noted that no plague occurrences were recorded among them, but we have nothing to show that they were kept under observation. (14,986.) So little was known of them that in the case of 822 persons no information of any kind is available as to their caste or social position. Plague occurrences may have taken place among them without being brought to the notice of the authorities as having occurred among inoculated persons.

Inoculations in Baroda Cantonments.

In concluding the consideration of information collected by us at Baroda, we have to deal with the facts which Major Sarkies, I.M.S. Residency Surgeon at Baroda, gave us with regard to inoculations in the Baroda Cantonment. Plague appears to have been severe in the Cantonment in March, and to have then declined until September and October, when it again became severe, and though we have not been informed of the exact dates of the inoculations, we understand that a large number were done in March and another large number in September and October. (15,401, 15,431, 15,436.) Major Sarkies told us that a total of 2,048 persons were inoculated between November 1897 and December 1898, and that of these 330 were soldiers and their families, while the remainder were civilians. (15,401–2.) As to the uninoculated, Major Sarkies told us that "there were about 800 not inoculated in the regiment, including the families, and about 1,000 in the bazar." (15,403.) The strength of the inoculated and uninoculated respectively was computed by simply subtracting the total number of inoculated persons from the total population of the Cantonments, which was apparently known to have been about 4,000. (15,475.) One hundred and nineteen cases with 94 deaths were reported to have occurred among the uninoculated, while the inoculated were reported to have had only 13 cases with 4 deaths, (15,426.) and Major Sarkies thinks that "that is a marked difference, as over half the people were inoculated." (15,424.) He, therefore, formed a strong opinion that inoculation was beneficial.

Examination of these figures shows that they make no pretence to accuracy. Moreover, as the period covered by the inoculations was clearly a prolonged one, no comparison between the inoculated and uninoculated is possible, except by comparing the incidence of plague upon the average strength of each class. But we do not know the period of observation during which the cases and deaths occurred. Further, we are unable to determine the average strength either of the inoculated or of the uninoculated, and this is a matter of considerable importance, as about a quarter of the whole number of the inoculated are said to have left the Cantonments, and there was probably an exodus among the uninoculated also. We can, therefore, make no accurate comparison between the inoculated and the uninoculated, but we see no reason to reject the opinion offered to us by Major Sarkies in favour of inoculation after an extended observation of its results in the Baroda Cantonment.

V.(11.) *The Punjab.*

Inoculations in the Punjab.

Para. 101 of this Report.

449. Inoculation was not an important feature of the plague policy applied to Punjab. The population of the villages in which plague appeared, up to the end of September 1898, was about 92,000, but the number of people inoculated in these villages was small. As is stated by Captain James, I.M.S., in his Report on the Punjab, "in the two infected areas there were 3,918 people inoculated. Among these there were eight attacked with plague in the Jullundur district and only one died, and that a woman who was proved to have had an insufficient dose of prophylactic." In the Jullundur district the number of the inoculated amounted to 2,408, while in the Hoshiarpur district the number was 1,510. The people were unwilling to submit to a second inoculation, and we are told that only 103 were inoculated twice.

Captain James' Report. 10,167.

In considering the details which have been placed before us regarding these inoculations, we find that the prophylactic fluid was not much used in the Punjab under conditions which put it to any considerable test of its efficacy. Thus we find that of the inoculations done in the Jullundur district, 244 were done in the village of Thandian and 372 in the village of Dasanjh, where there was no plague. Moreover, 209 were done in Khatkar Kalan in a camp of 600 people in which no plague occurred after the inoculations, except in the case of one inoculated person, who probably had been infected before

10,674–8. 10,861.

his inoculation. Similarly, although a number of people—variously stated as 801 and as 826—were inoculated in Garhshankar, out of a population of 5,000 to 6,000, we find that the inoculations were not done till the 11th May, and the plague outbreak in the place had by that time practically ceased, for out of a total of 152 plague cases which occurred among the people of the town, only five occurred after the inoculations were begun.

Inoculations at Banga, in the Punjab. 10,172. 10,235.

Banga Town is the only place in the Punjab regarding which we need go into any details of the progress of inoculation and the course of plague. The first case in this town occurred on the 7th March 1898, though the authorities did not hear of the existence of the disease until the 11th of that month. The last case took place on the 20th June, and the total number of attacks was 103, with 65 deaths. A census of the population was taken in March, and showed that there were 4,917 residents of the village. Evacuation, disinfection, and inoculation were all commenced on the day when plague was discovered and were completed about the 29th of April. As the people did not at first show themselves very willing to come forward for inoculation, the inoculations proceeded gradually. On April 30th, the number of the inoculated amounted in all to 865. It is remarkable that among the inoculated in Banga a very large number of children under 10 were included. Such children numbered 292, or more than 33 per cent. of the total number of the inoculated, a proportion which is very different from that noticed in other places. 10,178.

10,172.

Captain James, in commenting upon the results obtained in this village, remarks that 2·18 per cent. of the whole population were attacked, while the attacks among the inoculated amounted to ·69 per cent., and all the inoculated had the disease very mildly. In a case like this, however, more correct results could have been arrived at by calculating percentages upon the average strength of the inoculated and uninoculated respectively. We have not before us materials which enable us to do this.

List of plague infected families in Banga and investigation sheets put in by Capt. James, I.M.S. 10,173–7.

In addition to summing up the results for the village as a whole, Captain James has given us a list of all families in Banga in which plague cases occurred. This list shows the number of inoculated and uninoculated persons in the families and of the plague occurrences among them. In the case of houses in which inoculated persons were attacked, Captain James has supplemented his list by fuller details in the form of investigation sheets. An examination of the list shows that while details are given with reference to 81 families, the 103 attacks which took place in the town were distributed over 70 families only. A summary of particulars regarding all the families entered in the list is given below in tabular form, but we may point out that a statement of this sort is of no value unless we can assume that the cases among the uninoculated all occurred after the members of their households, who are set down as inoculated, had already undergone the operation:—

—	No. of Houses.	Inoculated Residents.		Percentage of Attacks on Total Number.	Uninoculated Residents.		Percentage of Attacks on Total Number.
		Total Number.	Number attacked.		Total Number.	Number attacked.	
	7	10	0	—	19	0	—
	2	7	0	—	0	0	—
	2	0	0	—	12	0	—
	1	3	1	—	0	0	—
	43	0	0	—	143	55	38·5 p.c.
	26	54	5	9 p.c.	107	42	39·2 p.c.
Total	81	74	6	—	281	97	—

When we collate with data set down in the general list of affected families the particulars which Captain James has given in his investigation sheets for the six houses in which inoculated persons were attacked, we find that the particulars in the cases of the houses referred to in the investigation sheets numbered 1, 3, and 5, do not agree with the details which have been given us in the general list. For instance, the investigation sheet numbered 1 states that the house to which it relates contained two inoculated persons, of whom one was attacked, and three uninoculated persons, of whom two were attacked; but the general list of families shows that in the family in question there were three inoculated persons, of whom one was attacked, and two uninoculated persons, who were both attacked. It is unnecessary to set forth here the similar discrepancies which occur between the details given in the investigation sheets and in the general list of families in the case of the other two houses of which the particulars are not the same in these two statements. It appears, in view of the discrepancies just referred to, either that one or the other of the two statements sets forth the facts of the case incorrectly, or, perhaps, that one statement refers to the number of people who occupied the houses in the town before evacuation, and the second to the number of persons who occupied various huts in camp after evacuation. Whatever the explanation of the discrepancies may be, these discrepancies are such that we cannot use the investigation sheets laid before us as the basis for accurate conclusions as to the amount of protection conferred against attack. But the fact that all the six cases of plague which occurred among the inoculated ended in recovery is of itself evidence of the beneficial effect of inoculation.

Inoculation of disinfecting gangs in the Punjab. In the Punjab special attempts were made to protect by inoculation persons who were engaged in working on disinfection gangs, and were thus subject to great risks of contracting plague. But the exact numbers of the disinfecting staff who were employed, and their distribution among inoculated and uninoculated, are unknown. Regarding the disinfectors employed in the Jullundur District, we have no full
10,006-8. particulars. We are, however, told that the inoculated had one genuine case of plague and one case regarding which it was doubtful whether it was plague or not. As to Hoshiarpur, we are told that cases among the disinfecting gangs occurred in every
10,685-6. village that was being disinfected, but that after inoculation had been introduced into the gangs, cases occurred only among the uninoculated disinfectors. After the inoculations there were only three cases, one in each of the gangs employed at Garhshankar,
10,690. Garhi, and Bilron. In the Garhshankar gang there were about 800 coolies, of whom
10,693-4. 700 were inoculated; in Garhi, out of 80 coolies, 60 were inoculated; and in Bilron,
10,691. out of about 60 coolies, nine were inoculated. The total number of the uninoculated was, therefore, 170 as compared with 770 inoculated coolies, and the fact that the 170 uninoculated had three cases, while the 770 inoculated had no cases, is some index of the efficacy of inoculations.

V.(12.) *Belgaum Town and Cantonments.*

Inoculations in Belgaum town. 450. We may now return to the consideration of the results obtained by inoculation in Southern India, and in this connection we may consider in particular the facts put before us regarding Belgaum, Satara, and Alibag.

Inoculations were introduced into the town of Belgaum in December 1897, and the period of observation covered by the figures which have been supplied to us regarding inoculated persons extends over one year, to the end of December 1898. This covers
23,127. the two periods of very severe plague mortality. Plague did not reach the town till the end of November 1897. It was most severe during January 1898, and died out in the second week in May. Another outbreak commenced very shortly afterwards in July 1898, and this, after attaining its period of greatest severity in October, ceased in January 1899. The officers personally responsible for the work connected with the inoculations and the maintenance of the records of inoculated persons did not appear before us as witnesses. The information with which we were supplied was given to us by Mr. Carmichael, the Collector of the district, Lieut.-Colonel Peters, I.M.S., Civil Surgeon, and Mr. Uchgaonkar, the Chairman of the Belgaum Municipality.

Statistics regarding inoculations in Belgaum. We learn that inoculations began on 26th December, 1897, but we are left in some doubt as to the exact number of persons who were inoculated. Mr. Uchgaonkar put in a statement showing this number to be 3,438, but he withdrew that statement,
23,131, 23,152-3. and supplied us with another, printed in his evidence. In this statement the number
32,133. of persons operated upon in Belgaum is represented by the total of 3,447, of whom a total of 2,565 are shown as belonging to the town itself, while 292 are entered as residents of the Cantonment, and the rest as residents of other places. We find, however, that the details given in the statement of the number of inoculated residents
23,132. of Belgaum town total up to 2,466. Between the date of the commencement of inoculations and the 15th January, 1898, inoculated persons were not liable to segregation or removal to hospital, but after the 15th January the ordinary plague measures were applied to the inoculated in the same way as to the uninoculated. The result of this withdrawal of the privileges at first conferred was, says Mr. Uchgaonkar, "to put almost a complete check to further progress of inoculation." The statement put in shows that of the total operated upon, 1,466 persons were inoculated between the 26th December 1897, and the 16th January 1898, and that only 1,000 persons submitted themselves to the process in the next 11½ months, of whom about 450 were done in the last fortnight of September. The number of inoculations performed in the town, which
Para. 53 of this Report. has a normal population of about 30,700, was thus very small, but it is apparent that the majority of those inoculated were operated upon before the climax of the first outbreak, and that practically the whole of the inoculated were operated upon before the second outbreak became severe.

Criticism of statistics for Belgaum town.

No attempt has been made to work out estimates purporting to be accurate with
regard to the relative amount of protection which inured to the inoculated when
compared with the uninoculated. But we have been informed that of the people
inoculated 61 or 62 were attacked and 33 died. We do not, however, lay any stress 23,134, 23,143.
on these figures, for we have it in evidence that the reporting of cases during the
first outbreak left much to be desired, and though the people, it is said, "gave 23,136–8.
information" during the second outbreak because they were not removed to hospital,
our general experience of plague statistics in India leads us to believe that this information
can hardly have been complete. Moreover, even if it were the case that
occurrences of plague were not concealed, we have good reason to believe that,
when they occurred in inoculated persons, they were not always correctly assigned to
the inoculated. The information which has been prepared and supplied to us regarding 23,142,
the number of the inoculated who were attacked was not, it would appear, compiled 22,929–36.
from inquiries made at the time of the attacks. We understand that the register of
plague attacks and deaths was, sometime before our visit to Belgaum, collated with the
inoculation register. When a name which appeared in the inoculation register appeared
also in the register of attacks, the case in question was entered up as occurring among
the inoculated. When, on the contrary, a name which appeared in the inoculation
register was not found in the register of attacks, the person in question was, unless
other evidence to the contrary was forthcoming, assumed to have escaped infection.
It is clear from the evidence which we have recorded that the statistics thus collected
were far from correct. Mr. Carmichael said :—"It is very difficult to identify the
inoculated people in several cases, because there was often a single name entered,
and very little else. A certain proportion is like that. In other cases the name, the
number of the house, and the occupation of the person are entered in our inoculation
register. They are arranged alphabetically; and we went over our attack register
and death register and checked the names. That is the way we did it. . . . The
attack and death register gives the streets and houses; and it also is supposed to
say whether a man was inoculated or not. That, however, has not always been given."
Mr. Carmichael added, that in a few cases nothing but the name of the person inoculated
had been entered in the register of inoculated persons. Lieut.-Colonel Peters, after 23,079–92.
an inspection of the registers relating both to the town and the Cantonment, told us
that, in the case of the town, entries in the register regarding the residence of the inoculated
were made "in a general way . . . the street had been entered, and sometimes
the number of the houses also"; but he had not examined the books closely enough
to say whether in all cases the residence was noted in the town registers. The town
registers, however, were very similar to those of the Cantonment and similarly kept up.
Therefore it is probable that mistakes found by Lieut.-Colonel Peters in the Cantonment
registers appeared also in the town registers. He informed us that "in the Cantonment
some names were not put down at all, but it was simply stated that a certificate
was given to a sepoy of the 26th Madras Infantry. . . . I should like to state
that in one case a woman left the camp with a certificate of Major Minchin that she
had been inoculated, and it was found on inquiry that her name was not on the
register. In other instances I have recently (in the beginning of 1899) found that transport
mule drivers and dooly-bearers, of the Commissariat, who had been inoculated,
are not recorded in the Cantonment registers," although their inoculation papers were
dated in September, October, and November, 1898. He added that "In the nominal
roll of inoculated persons in the Belgaum Cantonment who have got plague, I have a
number of names which have been recorded who came to the Civil Hospital after
having plague, and from inquiries I found out that they had been inoculated, but
the names cannot be found in the inoculation register." That names were omitted
from the town as well as from the Cantonment registers is clear from the following
cases, of which Lieut.-Colonel Peters told us. In the special inquiries which he made in
the case of four houses in the town, which we shall presently consider, he found that the
inoculation of two out of 10 persons said to be inoculated was incapable of verification. 23,108.
Further, he stated that 11 inoculated persons from the town and 49 from the 23,093–102.
Cantonment came to the hospital suffering from plague. Three only out of the 49
who came from the Cantonment could be traced in the registers as inoculated, and only
eight out of the 11 who came from the town could be similarly traced. We are,
however, without exact information as to the actual extent to which the accuracy of
the figures was affected by the causes of error which existed, and in these circumstances
it is impossible to accept the statistics with which we have been supplied as even
approximately correct. Any attempt to draw accurate deductions from them would
be fruitless.

In addition to the facts and figures which have been given us regarding inoculations in the town of Belgaum, as a whole, we have been supplied with particulars regarding inoculations in several different groups of persons living in Belgaum. These particulars relate firstly to the troops stationed in the Cantonment; secondly, to two groups of persons who came under the observation of Major Forman, R.A.M.C.; and thirdly, to the residents of four houses regarding whom special inquiries were made by Lieut.-Colonel Peters, I.M.S.

Inoculations in the 26th Madras Infantry at Belgaum. 25,930.

We may consider first the case of the troops. The regiment regarding which we have particulars is the 26th Madras Infantry. The first recognised case of plague in this regiment occurred on the 12th November, 1897, and the patient died on that day. Between this date and the 21st November, a period in which the regiment remained in its lines, there were 13 attacks of plague among the troops, families, and followers. On the 22nd November steps were taken to evacuate the lines, and evacuation was completed on the 28th November. During the period in which evacuation was proceeding, 15 attacks of plague took place. The whole regiment with its families and followers was moved into camps outside the town, and in the 10 days following this removal to camp, 13 sepoys and 21 members of their families and followers were attacked. After this the cases fell off in number from the 8th December, and only one or two attacks were occurring weekly by the time when Major Bannerman, I.M.S., arrived and proceeded to commence inoculations on the 23rd December, 1897. (25,927.) By this time there had been altogether 78 cases and 49 deaths from plague in the regiment. (25,928.) Out of the total population of 1,746, 1,665 were inoculated, and 81 only remained uninoculated. (25,932.) Immediately after inoculations were completed on the 6th January, the regiment went back to the disinfected lines, and during the rest of the period of the first outbreak in Belgaum, including the period in which that outbreak reached its height, there were only two attacks in the regiment, one in a sepoy and one in a European officer, both of whom had been inoculated. (25,932-3.) The regiment remained free from plague until the second outbreak took place in Belgaum. On the reappearance of plague in the town, the troops, families, and followers were re-inoculated at their own request, and at the end of the re-inoculations 1,801 persons had been inoculated. (25,939-40.) As men came back from time to time from furlough or recruiting duty, or as the families which had been absent during the first inoculations returned to the lines, they were inoculated, and after completion of the second series of inoculations there can have been very few inhabitants of the lines who had not been operated upon. The number of these is indeed stated to have been less than 81. It is probable that the real number of uninoculated persons living in the lines was unknown, and that, as in the case of the troops at Bangalore, the uninoculated cases may have occurred among persons who visited the lines and were discovered to have plague there. (Para. 444 of this Report.) Whether this was so or not, it is obvious, from the fact that the bulk of the uninoculated were people who had just joined the regiment, that the uninoculated cases must have occurred among persons who contracted plague while they were not living under the same conditions as the inoculated, and who may have been more exposed to risks of infection. The regiment therefore does not contain satisfactory controls enabling us to compare the occurrences of plague among the inoculated and the uninoculated respectively, as a method of gauging the advantages of inoculation. Nevertheless it will be of interest to consider the course of plague during the second outbreak in the regiment.

Course of plague in second outbreak among 26th Madras Infantry at Belgaum. 5621.

We have before us two statements of what occurred during the second outbreak. One of these is that of Major Bannerman, who has dealt with the whole period of the outbreak; and the second is that of Lieutenant Lethbridge, I.M.S., who was employed in inoculating the regiment the second time, and was able to observe what occurred during a period from the 5th September to the 15th October while he was at Belgaum. Major Bannerman's account differs from that of Lieutenant Lethbridge with regard to the date on which the re-inoculations were done, for whereas the former states that they were begun on 18th August and completed by the beginning of September, Lieutenant Lethbridge, who performed the operations, informed us that they were commenced on the 10th September and completed in about ten days. (5625-6, 25,940.) Moreover, Major Bannerman informed us that the second outbreak lasted from July to December, and that the inoculated had nine cases with three deaths; while the uninoculated had three cases all fatal. (25,934-8.) The number of cases among the inoculated was, he said, one only in each of the months of July, September, November, and December, with two cases in August and three in October; while the number of cases among the uninoculated occurred one in each of the months of September, October, and November. According to this account, therefore, during the whole of the months of September and October there were altogether four cases among the inoculated, and two among the uninoculated. But Lieutenant Lethbridge has told us that in the five weeks of September and October during which the regiment was under his observation, eight cases of plague with five deaths occurred among the inoculated, and that about the same number of suspicious cases also occurred, in which "they did not exactly know whether it was plague or not." Of these latter four died. Lieutenant Lethbridge also says that, in the period to which he refers, no cases occurred among the uninoculated, as there were no uninoculated. Major Bannerman was not with the regiment during the second outbreak. We therefore found some difficulty in accepting his figures in face of the evidence given before us by Lieutenant Lethbridge who had the regiment under his immediate observation while he was at Belgaum. This difficulty has been to some extent removed by the fact that the figures produced by Major Bannerman are vouched for both by him and by Lieutenant-Colonel Bennett, I.M.S., who was in charge of the regiment. But nevertheless, the method of the compilation of the figures given by Major Bannerman would, in face of Lieutenant Lethbridge's evidence, require to be more fully investigated before those figures could be accepted as absolutely correct. As they stand, in view of the possibility that they do not include every case that occurred, and in view of the probable incomparability of the inoculated and uninoculated communities in which the recorded cases occurred, and in view, further, of the fact that the numbers of the uninoculated are not accurately known, we are unable to accept the comparison based on them by Major Bannerman to show the relative liability to plague of the inoculated and uninoculated respectively within the regiment itself. Another comparison, however, has been made by Colonel Bennett and Major Bannerman in a paper published in the "Indian Medical Gazette" for June 1899. This comparison is between the number of cases that occurred in the regiment in the first outbreak and the number that occurred in the second outbreak. In the first outbreak there were in all 80 cases; in the second outbreak there were only 12. In view of the fact that the sanitary measures adopted in both outbreaks were similar, except only in respect of inoculation, and that the plague in the town of Belgaum was, during the second outbreak in the regiment, much more severe than the plague which prevailed in the town during the first outbreak in the regiment, it would hardly appear to be open to doubt that the practical immunity of the regiment during the second outbreak was due to inoculation.

5621-3 5642.

5644.

5646.

Groups of persons observed by Major Forman, R.A.M.C.

The groups of persons concerning whom Major Forman, R.A.M.C., gave us evidence, were his private servants, and the hospital attendants of the Belgaum Station Hospital with their wives and children. He inoculated these groups when plague first broke out in the town, and was able to keep in touch with them continuously after that time. Regarding the first group, he says, bringing down their history to the 3rd March 1899:—"Of my private servants there were in all, including their wives and children, 28 people inoculated. There have been no cases of plague, and no deaths up to date. There were three uninoculated. One was a child of nine years of age, whose father refused to allow it to be inoculated. It died of plague 12 days after the other people were inoculated. I diagnosed the case myself as plague. The other two cases that were not inoculated were not so distinctly under my own observation. One was a sweeper employed in the Cantonment as a municipal sweeper, the husband of my sweeper woman, and sleeping in my compound. He, I am told, died of plague some months afterwards. The other was my bhisti (water-carrier). He threw himself into a well. I was informed that he had buboes and fever, and ran away to escape segregation. Of the 28 inoculated, none died of plague; and of three uninoculated, two are said to have died of plague, and one undoubtedly died of plague." 23,797-9.

Regarding the second group of which he gave us particulars, Major Forman said that, out of 90 hospital servants, 87 were inoculated. Of the inoculated persons one died from fever and endocarditis, and one died of plague. Excepting these two, the rest of the inoculated were alive and well in March 1899. Only three persons remained uninoculated. Of these, one was not operated upon, because she had recently been delivered, another was not operated upon because she was pregnant, and the third was a boy of 16 years of age, whose father refused to let him be inoculated. The boy died of plague less than two months after the inoculation of the rest of the hospital servants had been done. One of the two uninoculated women died of plague two days after the boy, she having been in attendance upon him while he was sick with plague. The other uninoculated woman remained well. 23,797-9.

II. 428–42.

These particulars which Major Forman has given us regarding persons who came under his special observation are interesting, but we cannot attribute as much importance to them as to statistics collected over a larger area. While it is clear that isolated instances, like these, tell in favour of inoculation, it is equally clear that other isolated instances might tell against inoculation and that these could be obtained with little difficulty. A large number of such instances could, we may note, have been selected from the investigation sheets which Mr. Kaka put before us at Karachi. While, therefore, we have set forth the facts observed by Major Forman, we cannot consider that isolated cases of this kind are useful as a basis for deductions of general application. These cases, however, were not in the least cases which were selected to demonstrate the advantages of inoculation, and they are, for this reason, worthy of some weight in our consideration.

Groups of persons observed by Lt.-Col. Peters, I.M.S.
23,108–15.

The third group of cases which we have to consider in connection with Belgaum is that which relates to four houses inhabited by inoculated and uninoculated persons, for which Lieut.-Colonel Peters collected special information. These four houses contained 10 inoculated persons, of whom four got the plague and all recovered. Five persons who were uninoculated were residents of the houses, and there was no case of plague among them, but it is to be remarked that one of these uninoculated people was a child aged only three years, and another was a baby eight months old.

V.(13.) *The Town of Satara.*

Inoculations in Satara town.
22,393.

22,393.

22,390.
22,155.

22,480.

451. The inoculations that were done at Satara do not require more than a brief notice, and it will be convenient to consider them here. Intelligent members of the native community co-operated with the district authorities in recommending inoculations; public meetings were held to bring its advantages to the notice of the people, and the police were inoculated; people from infected places were removed to segregation or health camps unless they submitted to inoculation. Captain Thompson, I.M.S., who was in medical charge of the district, says of inoculation that "the people of Satara only resorted to it when we brought statistics before them to prove its great virtue," but the total number of people inoculated amounted to only 708 out of a population of nearly 26,000, and Lieut.-Colonel Hay, the Chief Plague Authority in Satara, told us that, in spite of inducements, the people showed no desire to be inoculated. We are informed that of the inoculated only three died, all on the first day after inoculation, and Captain Thompson has given us a table in which he compares the incidence of plague among the uninoculated people who were segregated with the incidence among the inoculated people in certain wards which were infected and had to be evacuated. The non-inoculated were removed, and the inoculated were allowed to remain in or return to their houses. The table which Captain Thompson furnishes is as follows:—

Name of Ward.	No. of Houses.	No. of Infected Houses.	Population.	No. of Persons inoculated.	After Segregation among the Non-inoculated.		After Inoculation among Inoculated.		Remarks.
					No. of Plague Cases.	No. of Plague Deaths.	No. of Plague Cases.	No. of Plague Deaths.	
Durga -	78	2	333	60	3	2	—	—	Evacuation commenced at the beginning of Nov. and inoculations were done about the same time. No case since 17th Jan.
Raviwar -	68	13	292	107	13	10	1	1	Inoculations were done about the beginning of Dec., when the ward was evacuated. No case since 6th Dec.
Pantachakote -	75	12	160	83	10	7	2	2	Evacuated on the 10th Nov. Inoculations were done between 11th Nov. and 11th Dec. No case since 24th Nov.
Totals -	221	27	785	250	26	9	3	3	

In all these wards the period of observation extends to the 31st March 1899. The data, however, are not complete enough to supply a basis for any estimation of the effects of inoculation, inasmuch as the table does not give the total number of attacks among the uninoculated in the wards, but only the number of attacks that took place among such uninoculated persons as were removed to segregation camps. Colonel Hay stated his opinion that the uninoculated people who went away from Raviwar 22,160. Ward had plague among them, but he is unable to give the number of attacks or deaths, and there was probably more plague among the uninoculated inhabitants of the wards than would appear from Captain Thompson's figures.

V.(14.) *The Town of Alibag.*

Inoculations in Alibag.

452. The last of the inoculations that we have specially considered in our survey of the results of inoculation, are the inoculations done in Alibag, near Bombay. The evidence which has been laid before us regarding these inoculations relates in the first place to general results in the town, and in the second place to the results of inoculation in certain households concerning which Mr. Arthur, the Collector of the district, has furnished special information.

The outbreak, during which inoculations were applied to the town of Alibag, commenced on the 24th December 1898 and had not ceased by the 20th March 1899, 25,876-91. when Mr. Arthur gave his evidence before us. Inoculations were commenced on the 2nd February 1899, and though the people were at first afraid of it, a certain number were afterwards induced to submit to the operation. The plague policy which was adopted was similar to that adopted in many other districts. The uninoculated were evacuated from their houses; the inoculated were allowed to remain. A peculiar feature of the plague policy adopted was that at the outset inoculation was withheld from the inhabitants of infected houses. Mr. Arthur says: "When infection was first introduced in Alibag I did not allow the members of infected families to be inoculated, lest the plague should be incubating in them, and lest their death from plague should be wrongfully assigned to the effect of inoculation; but latterly, inoculation having become more popular, I have revoked this order and have allowed the families to be inoculated, and then allowed them to go to their homes instead of being segregated." The result of this policy was that in a short time after plague broke out the town was occupied only by inoculated people, and by a few uninoculated people who were about to be inoculated. The number of inoculated persons who, according to Mr. Arthur's estimate, were living in the town at the end of March, was about 700. The other inoculated persons were, we presume, living outside the town. Mr. Arthur informs us that there were only 40 uninoculated residents in the middle of February, and only 20 at the time of his examination, but that the number of uninoculated was not definitely known. It would seem probable that there cannot have been many more uninoculated in the town, for orders were issued that "no one uninoculated should sleep in the town, and that those who did so would be prosecuted if discovered." These orders seem to have been strictly enforced and prosecutions were actually resorted to. Before proceeding to consider the results of these inoculations we may briefly summarise the conditions under which the inoculated and the uninoculated were living. Inside the town, and presumably under conditions that were favourable to correct observation, was living a community of 700 inoculated persons among whom were interspersed a few uninoculated persons. Outside the town there was a large community consisting chiefly of uninoculated persons over whom the supervision of the authorities was probably not very strict. The community inside the town was, by the nature of the case, more exposed to plague infection than the community outside; but on the other hand, there had been excluded from the former community, as we have seen above, most of the contacts who, of course, were most liable to develop plague.

Criticism of result for Alibag as a whole. 25,884.

Up to the date of Mr. Arthur's examination the inoculated were reported to have had only two deaths from plague. Up to the same date, reckoning from the 31st January, which practically corresponds with the date of the commencement of inoculations, 54 attacks from plague had occurred among the uninoculated. We can arrive at no conclusion from these statistics, for we have not been informed what was the average strength of the inoculated and the uninoculated during the period of observation, and further we are left in doubt as to whether the figures regarding plague occurrences are to be referred to the numbers of inoculated and uninoculated living inside the town or to the total number of inoculated and uninoculated, both inside the town and in camps outside it.

Special cases showing effects of inoculation in Alibag.

25,878.

In these circumstances it is unnecessary to dwell further upon the statistics which Mr. Arthur has given us for the town generally, and we may pass on to notice the special instances which he has laid before us of households in which inoculated members escaped while uninoculated members got plague. These may be quoted in Mr. Arthur's own words. Mr. Arthur says: "The first instance I can give is this: On 21st February there were in the police lines about 130 inoculated persons, and about 21 uninoculated. They were being gradually inoculated, but these 21 had remained till the end. One of these, Rakmi, wife of Gangnak, Head Constable, was attacked with plague on the above date and died on the 22nd. Another, Rama Shripatrao Sinda, was attacked on the 18th and died on the 24th—two cases. The remaining persons then uninoculated were inoculated within the two or three days following, and though 150 persons have since been living in the lines, and are living there now, there has only been one other case of plague there. This was Parbati, wife of Ragnak Rannak, who, having been inoculated a fortnight previously, was attacked with plague on the 8th of March. She had high fever one day, was better the second day, and on third day she was almost well; and within a very few days was restored to perfect health. Beyond that there has not been another case in the police lines. 25,879. . . . . . The second instance I wish to bring to notice was also a striking one. A Koli family of seven members was living in the town, of which six members had been inoculated in February. The remaining one, Hasu, wife of Nathu, having been delivered of a child only two months ago, was uninoculated. She caught the infection about the 8th instant, and died on the 14th in hospital. None of the other members of the family were affected, and the child was weaned from her, inoculated, and is now thriving. The third instance is also that of a Koli family of three members living together in the town. Of these, two were inoculated on the 9th and 17th February respectively. The third, a little girl of 12 years of age, who was to be inoculated later, was attacked with plague on the 1st instant, and died on the 3rd. The other two members were not affected. The fourth instance is that of a family of goldsmiths living in the town. Govindshet was inoculated in February. His daughter, Rembai (uninoculated), was attacked on the 7th instant, and died on the 8th. His wife, Bhagirthi, was inoculated the same day, and has not been affected. The fifth instance is that of a Musalman family of eight; of these, three were inoculated in February. Ismail, the son of one of them, 11 years of age (uninoculated), left Alibag on the 2nd and showed symptoms of plague on the 4th. He died on the 14th. The remaining members of the family were inoculated on the 4th, and none of the seven members now remaining have been attacked. . . . 25,880. Three were inoculated before the first case occurred and the remainder were inoculated on the case occurring."

As in similar cases considered in connexion of the effects of inoculation in Belgaum, we think it would be unsafe to found on special instances of this kind any general conclusions as to the amount of protection conferred by inoculation.

VI.—GENERAL SYNOPSIS OF STATISTICS ON WHICH CONCLUSIONS CAN BE BASED REGARDING THE VALUE OF INOCULATION WITH HAFFKINE'S VACCINE, AND OBSERVATIONS REGARDING THE FORM IN WHICH THE RESULTS ARE SET FORTH IN THE SYNOPSIS AND BY MR. HAFFKINE.

Synopsis of more trustworthy statistics criticised above.
App. LIII. in Vol. II. of those Proceedings.
18,344-61,
19,261 *seq.*,
20,529-31.

453. We have now brought to a conclusion our critical survey of the data laid before us regarding the effects of inoculation. We have omitted from our survey only data such as those relating to inoculation among the Parsees of Broach, and among various groups of persons in Bombay, the detailed criticism of which would not, in our opinion, further the object we have in view. We will therefore now set forth the general conclusions with regard to inoculation which can be drawn from the body of evidence that has been submitted to us. It will facilitate matters if before proceeding to undertake this task we collect here in tabular form the statistical

results which seem to us to be specially worthy of consideration. These results are as follows :—

FIRST SYNOPTICAL TABLE.

Name.	Population under Observation.	Percentage of Plague Attacks on Population.	Percentage of Plague Deaths on Population.	Case Mortality (expressed in Percentages in Cases where the Number of Attacks exceeds 100).	Advantages accruing from Inoculation.						Remarks.
					Diminution of Plague Attacks in every 100 of the Inoculated Population.	Ratio of Plague Attacks among the Uninoculated to Plague Attacks among an equal Number of Inoculated.	Diminution of Plague Deaths in every 100 of the Inoculated Population.	Diminution of Mortality among Inoculated as calculated according to Mr. Haffkine's Method of Calculation.	Ratio of Plague Deaths among the Uninoculated to Plague Deaths among an equal Number of Inoculated.	Ratio of Fatality in Plague Attacks among the Uninoculated to Fatality in an equal Number of Plague Attacks among the Inoculated.	
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Byculla Jail - - (Para. 432 of this Report.)	Uninoculated - 172	4·	1·1	2 in 7	3·4	6·6 to 1	1·1	100	—	—	Only cases that occurred after the 4th February are included in this calculation.
	Inoculated - 152	·6	—	0 in 1							
Umarkhadi Jail - (Para. 437.)	Uninoculated - 203	4·4	2·5	5 in 9	2·9	3 to 1	2·5	100	—	—	The percentages are taken on the original numbers of the inoculated and uninoculated.
	Inoculated - 199	1·5	—	0 in 3							
Undhera - - (Para. 438.)	Uninoculated - 437	6·4	5·9	26 in 28	4·9	4·2 to 1	5·3	89·6	10 to 1	2·5 to 1	One of us, Dr. Ruffer, is of opinion that these figures are not trustworthy.
	Inoculated - 513	1·5	·6	3 in 8							
The troops at Bangalore - - - (Para. 444.)	Uninoculated 2,454	1·7	1·5	7 in 8	·6	1·5 to 1	·8	53·3	2·1 to 1	1·4 to 1	
	Inoculated - 446	1·1	·7	18 in 28							
Bulsar (4 Wards) - (Para. 447.)	Uninoculated - 62	14·5	11·3	7 in 9	6·3	1·8 to 1	8·3	73·5	3·7 to 1	2·1 to 1	
	Inoculated 1,018	8·2	3·	31 in 84							
Lanauli (C. and D. Wards) - - (Para 434.)	Uninoculated - 330	8·8	5·4	46 in 69	7·5	6·8 to 1	4·6	85·2	6·7 to 1	1·5 to 1	The figures relate to the period from the 5th August to the 23rd September 1897.
	Inoculated - 370	1·3	·8	6 in 13							
Kirki (followers of 4 batteries) - - (Para. 435.)	Uninoculated - 812	10·3	5·8	67·8 p.c.	7·9	4·3 to 1	4·6	79·5	4·8 to 1	1·3 to 1	The figures relate to the period from the 26th August to the 28th September 1897.
	Inoculated - 755	2·4	1·2	·53 p.c.							
Hubli (16th July to 19th August) - (Para. 439.)	Uninoculated 20,225	—	4·8	—	—	—	4·3	89·5	9·6 to 1	—	We think the figures for attacks untrustworthy. Dr. Ruffer thinks the figures for deaths also quite untrustworthy.
	Inoculated 22,967	—	·5	—							
Gadag (Mr. Foy's figures) - - (Para. 441.)	Uninoculated 8,687	2·7	2·3	83 p.c.	1·7	1·8 to 1	1·7	74·0	3·8 to 1	1·9 to 1	
	Inoculated 9,396	1·5	·6	44 p.c.							
Daman (62 houses) (Para. 433.)	Uninoculated - 123	—	—	38 in 55	—	2·2 to 1	—	—	4 to 1	1·7 to 1	
	Inoculated - 255	—	—	20 in 50							

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454. For the administrator the measure of success attained by the use of inoculations is represented by the actual number of attacks and deaths averted from the inoculated. This number can be ascertained for any particular place by multiplying the figures shown in columns 6 and 8 of the table given above by the number of hundreds composing the inoculated population.

Form adopted by us in stating results in above table and criticism of form of statement adopted by Mr. Haffkine.

In addition to the figures which show the diminution of plague attacks and deaths among the inoculated population, we have set down in the table figures showing the diminution in mortality, as calculated out according to the method adopted by Mr. Haffkine. This method, though it affords information which is of value to those who desire to ascertain how far the effects of the vaccine have approximated to the ideal standard which would have been attained if all cases of plague had been averted from the inoculated, gives results which are likely to convey a wrong impression to the administrator. It will be seen that, whereas the diminution of mortality which was achieved by the introduction of inoculations among the troops at Bangalore, amounted actually to ·8 per cent., it figures, when calculated out according to Mr. Haffkine's method, as 53·3 per cent. Similarly, in Undhera, the diminution in mortality which was actually effected among the inoculated was 5·3 per cent. Mr. Haffkine's statement of the result is, that there was "a reduction of 89·6 per cent. of mortality attributable to inoculation." I. 332. His method of calculation correctly represents the percentage which the number of lives saved by inoculation bears to the maximum number of lives that might have been saved, and he takes, as the maximum number of lives that might have been saved, a number corresponding to the number of lives actually lost on account of plague among the uninoculated. The method, however, is likely to give rise to misunderstanding, especially when it is made, as it has been by Mr. Haffkine, the basis for such a general statement as the following ;—" One can say in a general manner that the reduction in the mortality produced by inoculation is between 80 and 90 per cent." Such a statement, taken apart from the actual figures, might be taken to imply either that inoculation had averted death from 80 to 90 persons (*a*) in every 100 of the total population, or (*b*) in every 100 of the inoculated population, or (*c*) in every 100 inoculated persons attacked, whereas the statement really means that death was averted from 80 to 90 in every 100 of those who, without inoculation, would, judging by the mortality among the uninoculated, have died of plague. The misconception which might arise from the employment of this method of calculation will be most serious wherever the severity of the plague among the uninoculated is lightest; as, for instance, in the case of the light epidemic in the Byculla Jail. It will be seen that in that jail the diminution of mortality calculated by Mr. Haffkine's method would, on the figures given by us, amount to 100 per cent., whereas the actual saving in life achieved by inoculation would, on the same figures, be represented by the fact that death was averted from two of the inoculated persons.

With a view to avoiding such fallacies we have expressed our results in a form that is not open to these objections. In column 10 of our table, we have set forth the ratio in which the deaths among the uninoculated stand to the deaths which actually occurred among equal numbers of the inoculated.

Synopsis of additional figures regarding effect of inoculation on case mortality.

455. A further point regarding the table we have given above relates to the character of the statistical material which it contains. It is to be noted that the table, while it includes all the more important figures regarding the diminution of deaths and attacks achieved by inoculation, does not include the whole of the figures worthy of consideration in connexion with the effect of inoculation on case mortality. Regarding this we have some additional data derived from observations made in hospitals, and in order to complete the synopsis of the statistical material from which our conclusions will be drawn, these additional data may be set forth as follows :—

SECOND SYNOPTICAL TABLE.

Hospital at	Once and twice inoculated Patients grouped together.			Uninoculated Patients.			Ratio of Fatality among Uninoculated to Fatality among equal Numbers of Inoculated Persons.
	Admitted.	Died.	Case Mortality.	Admitted.	Died.	Case Mortality.	
			Per cent.			Per cent.	
Dharwar* - - -	104	30	29·0	653	404	62	2·1 to 1.
23,694–5. Gadag - - -	107	56	52·2	184	130	70	2·3 to 1.
25,025–7. Bangalore City - -	57	31	54·4	2,074	1,391	67	1·2 to 1.
25,025–7. Bangalore Civil and Military Station, North Camp.	87	24	27·6	853	572	67	2·8 to 1.
25,025–7. Bangalore Civil and Military Station, South Camp.	41	12	29·3	727	450	62	2·1 to 1.
III. 286. Bangalore Civil and Military Station, Military Hospitals.	121	80	66·0	69	59	78	1·2 to 1.
25,025–7. Mysore City - -	26	9	34·0	180	92	51	1·5 to 1.

* These figures are taken from a report on the Dharwar Plague Hospital from the 28th August to 18th December 1898, by Mr. Hornabrook, M.B., the Medical Officer in charge of the Hospital.

General statement of the protective effects of inoculation.

456. This and the foregoing table show that in every case, except that of Bulsar, inoculations had a considerable effect in warding off plague attacks from the inoculated, and that in every case without exception they rendered attacks among the inoculated less fatal than attacks among the uninoculated. The protection afforded by inoculation seems, however, never to be absolute, either in the matter of warding off attacks, or of warding off a fatal issue to an attack, and we have instances, in the statement of cases submitted to us with reference to patients treated in the Khoja Hospital at Bombay, which show that plague attacks may occur in persons inoculated as many as three or four times within 18 months of attack, and that such attacks may end in death. The facts thus established by actual experience in the case of man are

App. LV.(1) in Vol. III. of these Proceedings.

precisely such as might have been anticipated from the experimental results obtained in the case of animals subjected to anti-plague inoculation.

VII.—QUESTION OF THE MEASURE OF PROTECTION AGAINST PLAGUE AFFORDED BY INOCULATION WITH HAFFKINE'S VACCINE.

Great differences in results set forth in the synoptical tables above.

457. When we consult the tables with a view to determining what measure of protection is actually afforded by inoculation, we see great differences in the results which are set down for various places. These differences are noticeable in the results set down with regard to the diminution both of attacks and of deaths among the inoculated as compared with the uninoculated population. They are noticeable also in the figures for case mortality, which represent the diminution of the death rate among the inoculated as compared with the uninoculated patients who were admitted to hospital, or whose attacks came otherwise under the observation of the authorities.

In the case of the Byculla Jail the ratio which the attacks in the uninoculated bore to the attacks in equal numbers of the inoculated was 6·6 to 1. On the other hand, in the case of the troops at Bangalore the corresponding ratio was 1·5 to 1. The corresponding ratios in other places vary between the extreme limits which are represented on the one hand by the ratio in the Byculla Jail, and, on the other hand, by the ratio among the troops at Bangalore.

The ratios of deaths among the uninoculated to deaths among similar numbers of inoculated persons vary between 10 to 1 in the case of Undhera and 2·1 to 1 in the case of the troops at Bangalore.

The diminution of fatality in cases among the inoculated as compared with cases among the uninoculated was in the North Camp Hospital at the Civil and Military Station of Bangalore represented by the ratio of 2·8 to 1, the highest ratio observed; in the case of the Military Hospitals at Bangalore the diminution of fatality was represented by the ratio of only 1·2 to 1, which is the lowest recorded.

Possible explanations of differences in results.

458. The variations in the results may conceivably be explained in one of four ways. They may be due to errors in the statistics sufficiently serious to falsify the ratios; secondly, they may be due to the assignment to the inoculated in certain of the statistics of attacks and deaths which were imputable to infection contracted shortly before or shortly after inoculation; thirdly, they may be due to differences in the virulence of the plague epidemics in the various places where inoculation was employed; and, fourthly, they may be due to differences in the strength and amount of the vaccine employed in different places.

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VII.(1.) *Inaccuracies in Statistics an Explanation of the Differences in Results obtained in different places.*

Brief discussion of the accuracy of the figures in first synoptical table. Sections IV. and V. of this Chapter.

459. With regard to the suggestion that the discrepancies in the results may be conditioned by serious errors in the statistics, it is to be noted that this question, in so far as it applies to the first of the two synoptical tables now under consideration, has been already discussed in our detailed review of the statistical materials supplied to us. It will be sufficient to remark here that the statistics set forth in the first table are not all equally trustworthy. While, for instance, we may take all the figures given us for the Byculla and Umarkhadi Jails, and for the troops at Bangalore, to be as accurate as such figures can be, on the other hand we may notice that the figures given for Lanauli, Kirki, Hubli, and Gadag, cannot be compared with those just mentioned in point of accuracy. We may further note that the comparisons based on the figures for Bulsar are, as we have already said, unduly to the advantage of inoculation; while, in view of this fact, it would be illegitimate to use these figures as an indication of the advantages of inoculation, it will be legitimate to use them in guaging the liability of the inoculated to contract plague.

Discussion of accuracy of hospital figures for case mortality.

460. With reference to the figures for case mortality, however, we have not yet entered into a discussion of them, and we have, therefore, here to consider whether the differences of the effect of inoculation on case mortality, shown in different places, can be accounted for by differences in the conditions under which the various statistics were collected. We may begin by pointing out that patients who are really inoculated may, even in a hospital, occasionally be misclassified as uninoculated. This may readily occur in the absence of friends or relatives, or of a certificate of inoculation, in the case of patients who succumb without being able to render any account of

Para. 604 of this Report.

themselves. We have no means of determining the amount of error which might thus be introduced into hospital statistics. But in view of the fact that in many cases patients were moribund when brought into hospital, the point must be kept in mind. To the extent to which it occurred the error must have operated to the advantage of inoculation in increasing the difference between the case mortality set down for the inoculated and that set down for the uninoculated. The trustworthiness of the hospital figures for case mortality may, however, be impugned on more serious grounds. They may be impugned on the ground that the severity of the cases in inoculated and uninoculated patients respectively which are treated in hospital cannot be taken as representing, with a fair degree of accuracy, the average severity of the total plague cases among these two classes of the community. Consideration will show that the mildest cases and the severest cases of plague will not be adequately represented in hospitals, in as much as the mildest cases of plague will be able to avoid being taken to the hospital, and the severest cases will die before they can be brought in. It might be assumed *à priori* that this process of selection would influence the case mortality recorded for the inoculated and the uninoculated in opposite directions. In the case of the uninoculated it might be assumed that there would be excluded from observation in hospital a preponderating number of severe cases of plague, and only a very few mild cases of plague. In the case of the inoculated, on the other hand, in as much as the course of plague is favourably modified by inoculation, we might expect that there would be excluded from observation in hospital a large proportion of mild cases of plague, and only a comparatively small proportion of the severest cases of plague.

23,694-5.
23,727.

We find that the figures for Gadag harmonise with these inferences. We find that while the case mortality in the inoculated in the Plague Hospital at Gadag is set down as 52 per cent., the case mortality for the inoculated of the whole town is set down as 44 per cent., the reduction of case mortality in this instance being brought about by the inclusion, within the figures for the town as a whole, of 32 attacks of which only four were fatal. If we may make the assumption that in Gadag all the deaths are correctly assigned to the classes of the inoculated and the uninoculated respectively, and that all deaths from plague came to the knowledge of the authorities, it will be obvious that the figure of 44 per cent. cannot exceed the actual case mortality among the total inoculated population of Gadag. On the other hand, inasmuch as many mild cases must have escaped the notice of the authorities, we may assume that the actual case mortality may have been even below 44 per cent. In any case, it will be manifest that the case mortality of 52 per cent. obtained in the hospital, in all probability gives us an exaggerated estimate of the case mortality in the total number of the inoculated attacked. Precisely the contrary of this seems to hold true with regard to the uninoculated in Gadag. The case mortality for the uninoculated in the Plague Hospital at Gadag works out at 70 per cent., while the case mortality which is set down for the total uninoculated population of the town is 83 per cent. This increase in case mortality is obtained by the inclusion, in the figures for the town as a whole, of a large number of cases which came to the notice of the authorities only after the patients had died. We do not know the precise number of these cases and deaths. There appears, in fact, to be a serious inaccuracy in Mr. Foy's figures, inasmuch as when we subtract the figures which he has given us for cases and deaths in the hospital from the figures which he has given us for cases and deaths in the whole of the town, we arrive at the figure of 103 cases with 105 deaths.

Report on the Dharwar Plague Hospital.

We, however, cannot generalize from the case of Gadag. The figures obtained in other places do not tend always in the same direction. In the case of Dharwar, from the figures supplied to us from Mr. Hornabrook, we can institute a comparison between the case mortality of the inoculated in the hospital and the case mortality of the inoculated outside the hospital. Mr. Hornabrook's returns are divided into three parts. The first two parts bring the figures up to the 8th December 1898. The first part shows that, up to that date, out of 99 inoculated patients treated in the hospital, 27 died. The second part refers to inoculated persons attacked who were not brought into hospital. The result of the attacks is noted in 32 only of the cases included in this part. Of these 32 cases, 16 ended fatally. The third part of Mr. Hornabrook's returns brings the figures down to the 9th January 1899, but does not distribute them into cases that were treated in the hospital and cases that were not so treated. These figures show that in Dharwar the case mortality for the inoculated in the hospital was 2·74 per cent., while the case mortality for the 32 inoculated outside the hospital, expressed in percentages, amounted to 50 per cent. We may thus note that the case mortality for the inoculated who came under observation outside the hospital was greater than that of those who came under observation in hospital. The inference that in Dharwar plague was more severe in inoculated patients who did not come into hospital, in comparison with those who came into hospital, is borne out by a consideration of the details given in the third part of Mr. Hornabrook's returns. We find there 43 deaths set down as occurring in the cases of 69 persons, who appear, as we infer from internal evidence, almost all to have been seen outside the hospital. This result is quite other than that which might have been expected, both on *à priori* grounds and from the consideration of the figures for Gadag.

The different results obtained in Gadag and Dharwar respectively show that the case mortality for the inoculated in hospitals stands in no constant relation to the case mortality among the total inoculated attacked who have come under observation. *À fortiori* it can stand in no constant relation to the real case mortality of the total body of the inoculated attacked.

The above considerations throw some light upon the figures for case mortality which are set down for the various hospitals in the City, and Civil and Military Station, at Bangalore. In the case of the North Camp Hospital, we have a case mortality of 27·6 per cent. for the inoculated, and in the South Camp Hospital a case mortality of 29·3 per cent. for the same class. The case mortalities just referred to have been taken on 128 cases, two-thirds of which were treated in the North Camp Hospital and one-third in the South Camp Hospital. In contrast to these, we have the figures of the hospital in Bangalore City, giving a case mortality of 54·4 per cent., taken on 57 cases among the inoculated, and the figures for the Military Hospitals at Bangalore, giving a case mortality for the inoculated of 66 per cent., taken on 121 cases. It is to be noted that these very different results refer to one and the same plague epidemic. It is possible that an explanation of them, so far as they relate to the case of the Military Hospitals, may be found in the assumption that, while all the inoculated attacked in the military community were brought into hospital, many of the more severe cases among the inoculated in the civil population were not brought into hospital. Similar considerations apply to the case mortality among the uninoculated in the various Bangalore hospitals. It will be seen that while this amounted to 78 per cent. in the Military Hospitals, where the figures are likely to be least erroneous, it was only 67, 67, and 62 for the City, North Camp, and South Camp Hospitals respectively.

In conformity with the above considerations, the case mortalities among the inoculated and uninoculated in the hospitals cannot, except in hospitals such as Military and Jail Hospitals, be taken as representing the actual case mortalities of the inoculated and uninoculated classes respectively. Inasmuch as the case mortality of one of these classes may be affected in a different degree and a different sense to that of the other, it follows that the ratio between the case mortality of the uninoculated and that of the inoculated patients treated in hospitals cannot be accepted as a correct index of the advantage which has really accrued from inoculation. In proof of this, we need point only to the ratios set down in our tables for the hospitals in Bangalore City and the Civil and Military Station. While these ratios ought to work out practically the same, they vary in a most irregular way. In the Bangalore City and the Military Hospitals, where the conditions under which patients were brought into hospital were entirely different, they are 1·2 to 1. In the Civil Hospitals of the Civil and Military Station, to which patients were brought under conditions similar to those of the City Hospital, the ratios are 2·1 to 1 and 2·8 to 1. In these circumstances, though we have no doubt that the figures are sufficiently accurate to show that inoculation considerably reduces the case mortality of the inoculated, we shall be unable to make any use of the hospital figures in connexion with any exact calculations, except when such figures refer to Military or Jail Hospitals.

VII. (2.) *Question as to how soon after Inoculation Protection against Plague is afforded.*

461. We have now to consider the possibility that certain of the less favourable results shown in the tables which are now under discussion, may be due to the assignment to the inoculated of attacks and deaths due to infection contracted shortly before or shortly after inoculation. In certain of the statistics, that is to say those for Undhera and the Umarkhadi Jail, which record the most striking instances of the

Possibility that less favourable results are in some cases due to inclusion among the inoculated of persons who contract

plague before or immediately after inoculation. Paras. 437 and 438 of this Report.

advantages of inoculation, the good results obtained may, in a certain degree, be attributable to the fact that there were either few or no attacks among the inoculated, which are referable to infection contracted shortly before or shortly after inoculation. In the case of the Umarkhadi Jail, plague was entirely in abeyance for a fortnight after the inoculation. In Undhera, though plague continued among the uninoculated at the rate of 10 cases in the first week after inoculation, there were among the inoculated two persons, at most, who can be regarded as having contracted plague at the time of inoculation. The experiment in the Byculla Jail is of particular interest in this connexion. If we compare the number of attacks that occurred among the uninoculated and the number among the inoculated from the date of inoculation, we find that there was a percentage of 6·9 and 3·9 cases respectively among these two classes, giving a ratio of 1·8 to 1. But if, allowing 5 days for the incubation period, we exclude all cases that might have been incubating plague at the time of inoculation, we arrive at the results which have been tabulated above, and which give a ratio of 6·6 to 1. The inclusion of cases among the inoculated who were incubating plague at the time of inoculation, must influence every comparison based on average strength; it will be remembered that this method of comparison is resorted to only when inoculations are continued during the period of observation. This fact must be borne in mind in connexion with the less favourable results obtained in Kirki, among the troops at Bangalore, and possibly in the case of Bulsar. Regarding the dates of inoculation at this last place, however, we have no exact information.

Para. 432 of this Report.

Paras. 435, 444, and 447 of this Report.

Criticism of Mr. Haffkine's suggestion that protection is conferred within 24 hours.
44.
45.
47.

462. The assumption that the relatively less favourable results were due to the inclusion among the inoculated of persons who were incubating plague at the time of inoculation could not be made, if there were any reason to accept Mr. Haffkine's suggestion, that, "though the prophylactic was powerless to arrest symptoms already started, or which developed a few hours after inoculation," "there is a possibility of its influencing the disease in the incubation period in an individual infected three or four days previously," and that "the time necessary for the plague prophylactic to produce a useful effect is . . . apparently less than 24 hours." The results obtained by the Pasteur system of inoculation against rabies clearly show that an inoculation may afford protection against the effects of infection already contracted. Indeed, there is no reason for inferring that the period required for the achievement of protection must always exceed the incubation period of the disease protected against. Thus, theoretically, Mr. Haffkine's vaccine might quite well protect against infection already contracted. On the other hand, in view of the short incubation period of plague, and in view of the fact that our experience in the case of other diseases, both in animals and men, indicates that protection is not at all rapidly established, it seems to us unlikely that the anti-plague inoculation can exert any favourable influence on persons who are already incubating plague. The matter, however, is one which can be definitely determined only by scrutinising the records of actual observation to ascertain how soon protection becomes established. We have, therefore, endeavoured to gather indications regarding this matter from the evidence laid before us.

Para. 197 of this Report.

Possibility of determining by consideration of dates of attack how soon protection is acquired.

463. It would seem possible to test how soon protection is achieved by determining what percentages of the total attacks among the inoculated are attributable to each successive day or week after inoculation. We may consider first what details are necessary to apply this test. If we are dealing with a group of persons all inoculated on the same day, we should require to know the number of inoculated persons composing the group, the period for which they were kept under observation, and the number of cases that occurred among them in each day or week of the period of observation. It would, moreover, be necessary to know to what extent plague continued among the uninoculated during each day or week throughout the period of observation, in order to determine whether the inoculated in the concluding days or weeks of that period were or were not exposed to less infection than those in the earlier days or weeks. We could then calculate out the daily or weekly percentage of attacks, for the first day or week on the original number of inoculates, and afterwards on the number of these remaining over unattacked on each day or week. A comparison of the percentage of the attacks which occurred shortly after inoculation with the percentages which occurred later would give the required information as to the date on which protection was achieved. When the results of a series of inoculations done on

successive days in one community are in question, the same particulars regarding each successive group of inoculates will be required. This is not the method that has been adopted in the preparation of the statistics placed before us. The method adopted has been to bring the period of observation for a number of successive groups of inoculates to a conclusion on one and the same day, to sort out the cases that have occurred before that day into groups according to the length of time after inoculation at which they occurred, and then to compare the numbers of attacks in different days or weeks with a view to drawing conclusions with regard to the protection achieved at varying periods after inoculation. This method leads to erroneous results. How erroneous these results may be will be manifest when we consider what would be the effect of applying the method to an extreme case. In such an extreme case as that of a community composed of two groups of inoculates, inoculated on two days separated by a considerable interval of time, if the period of observation was brought to a close within, let us say, a week after the second series of inoculations, it is plain that the ratios which the percentage of attacks occurring in the first week after inoculation would bear to the percentage of attacks occuring in weeks remoter from the dates of inoculation would be vitiated by the fact that the figures for the first week would include the cases that occurred in both groups of inoculates, while the figures for the subsequent weeks would exclude the attacks that might have occurred among the second group of inoculates after the date on which the period of observation was brought to a close.

Possibility of determining by consideration of case mortality how soon protection is acquired.

464. We have gone through the figures supplied to us and find that they are presented to us in such a form as to make it impossible to arrive at any conclusion as to whether the percentage of attacks among inoculated persons has been greater or less in the first few days after inoculation than in the subsequent period. In default of the data necessary for the decision of this question we have fallen back upon the only other line of inquiry which seems open to us. In other words, we take the case mortality as our index of the protection acquired by the inoculated. We have gone through various statements laid before us, with a view to determining whether there are any differences between the case mortality in inoculated persons attacked during the first few days after inoculation and the case mortality in inoculated persons attacked at a later period. The most satisfactory and most detailed statement which we have to assist us in this matter is that furnished by Mr. Hornabrook. He has given us a statement of the cases of 208 inoculated persons. Of these we can here make use of 142 cases only, as the rest are those of twice-inoculated persons or of once-inoculated persons regarding whom full details are not given. Our examination of the 142 cases has given us the following results, which show the case mortality among the inoculated attacked on the day of inoculation, among those attacked on each of the five succeeding days, and among those attacked in the period after the expiration of five days.

App. XVI. in Vol. I. of these Proceedings.

Number of Cases among Once-inoculated Persons.

On Day of Inoculation.		On 1st Day after Inoculation.		On 2nd Day after Inoculation.		On 3rd Day after Inoculation.		On 4th Day after Inoculation.		On 5th Day after Inoculation.		After 5 Days after Inoculation.	
Cases.	Fatal Cases.	Cases.	Fatal Cases.	Cases.	Fatal Cases.	Cases.	Fatal Cases.	Cases.	Fatal Cases.	Cases.	Fatal Cases.	Cases.	Fatal Cases.
11	7	9	4	8	3	7	5	8	0	6	0	93	30

This summary of observations shows that the case mortality is very much higher in patients attacked during the first few days after inoculation than it is at a later period. In view of the fact that Mr. Hornabrook's list is the most extensive series of observations which we have, and that it shows that the case mortality is severest in the first three days after inoculation, we assumed that figures of other observers would, if scrutinised, likewise show that protection was definitely established only after the expiration of a similar interval. With a view to determine this, we have, wherever the data were available, worked out the case mortality in once-inoculated persons attacked within the first three days after inoculation. Similarly, with a view to instituting a comparison, we have worked out from the statistics in question the case mortality in persons attacked more than three days after inoculation. The result of the analysis of the figures is as follows :—

	Place.	Cases in Once-inoculated Persons attacked on Day of Inoculation and the subsequent Three Days.			Cases of Inoculated Persons attacked more than Three Days after Day of Inoculation.		
		Cases.	Fatal Cases.	Case Mortality.	Cases.	Fatal Cases.	Case Mortality.
				Per cent.			Per cent.
I. 429-38.	Dharwar (Mr. Hornabrook's figures).	35	19	54	107	30	28
II. 428-442.	Karachi (from Mr. Kaka's investigation sheets).	6	6	100	41	19	48·5
I. 310-30.	Daman (from Major Lyons' investigation sheets).	7	5	71·5	84	31	37
15,431.	Baroda (Major Sarkies' figures).	4	1	25	9	3	33·3
23,143.	Belgaum (Mr. Uchgaonkar's figures).	3	3	100	58	30	52
	Total - -	55	34	62	299	113	43·3

It is thus manifest that, while the case mortality of the first three days compares favourably with that of uninoculated patients, the protection which is achieved within the first three days after inoculation compares very unfavourably with that which is achieved later on. It is probable that this inference would be confirmed by the examination of other figures, if we had been able in other cases to distribute the plague attacks into those that occurred in the first three days after inoculation and those that occurred afterwards. We see an indication of this in the fact that when we institute, as we are able to do in certain instances, a comparison between the case mortality in persons attacked within seven days of inoculation, and the case mortality in persons attacked later, the case mortality for the former is less favourable than that for the latter. The figures to which we refer are as follows :—

	Place.	Cases of Persons attacked on Day of Inoculation, or within Seven Days after.			Cases of Persons attacked more than Seven Days from Date of Inoculation.		
		Cases.	Deaths.	Percentage.	Cases.	Deaths.	Percentage.
I. 333-6.	Undhera (investigation sheets) -	2	1	50	6	3	50
II. 428-42.	Karachi (investigation sheets) -	11	8	77·7	38	18	47·4
16,284.	Bulsar (details supplied by Mr. Dadachanji).	13	5	38·5	71	26	36
14,838, 14,940.	Biliimora and Koili (details supplied by Mr. Mehta).	6	4	66·6	33	21	63
1773.	Dharwar (details supplied by Miss Corthorn).	50	16	33	45	11	24·5
		72	34	47	193	79	41

VII.(3.) *Question whether Variations in Virulence of Epidemics in Different Places account for Differences of Results obtained from Inoculation.*

Possibility that variations in results of inoculation are due to variations in virulence of plague.
Para. 432 of this Report.
III. 285 (Stat. I.).

465. Another explanation of the discrepancies in the synoptical tables which suggests itself is that the protective effect of inoculation may be inversely to the virulence of the epidemic. Countenance would appear to be given to this explanation by the results shown for the Byculla Jail: here we have very good results, both as to the warding off of attacks and as to the reduction of fatality, in the case of an epidemic where the case mortality taken on the 26 uninoculated attacked during the whole course of the the epidemic was only 50 per cent. The explanation would also appear to be countenanced by the results of the inoculations done among the troops at Bangalore. Among them, in an epidemic whose virulence may be gauged from the fact that deaths occurred at the rate of 85 per cent. among the 69 uninoculated

attacked, we have much less favourable results for inoculation, both in reduction of attacks and in reduction of fatality. This explanation, however, is discountenanced by the fact that the results obtained in Undhera were many times better than the results obtained among the troops at Bangalore, though, since the virulence of the epidemic was slightly greater, worse results might have been expected. Moreover, the explanation would appear to be in conflict with the fact that, with regard to both attacks and deaths, the results obtained at Undhera, where the case mortality during the whole course of epidemic was 91 per cent. among the uninoculated, are much better than the results obtained in Bulsar, where, judging from the figures for the uninoculated Ghanchi Ward, we may take the case mortality among the uninoculated to have been 69·5 per cent. (16 deaths in 23 cases). The smaller effect produced in Bulsar is the more remarkable inasmuch as we have seen above that the comparison that has been instituted there between inoculated and uninoculated is unduly to the advantage of inoculation. We must therefore conclude that the explanation of the greater or less effectiveness of inoculation is not to be found in the variation in the virulence of the plague in different places.

Para. 438 of this Report.
Para. 447 of this Report.

VII.(4.) *Question whether Differences in Results of Inoculation are due to Differences in the Strength and Dosage of the Vaccine used.*

Possibility that variations in results of inoculation are due to variations in strength or character of the anti-plague vaccine.

466. We may now seek for an explanation of the varying effectiveness of inoculation by inquiring whether the result of inoculation is governed by differences in the vaccinating material injected. In respect of this question we may note that Mr. Haffkine himself has suggested that the effectiveness of the vaccine is conditioned by differences in strength. In confirmation of this suggestion he has drawn attention to the results obtained from the inoculations in Kirki and Daman.

68, 72, 119, 184–90.
Para. 453 of this Report.

First, in connexion with the results in Kirki, which Mr. Haffkine imputed to the defective strength of the vaccine, we may note that the first of our synoptical tables shows that in Kirki the protection against attacks was inferior only to the protection against attacks obtained in Lanauli. We may exclude from consideration here the figures for the Byculla Jail, where the epidemic was light. Similarly, the ratio of diminution in deaths among the inoculated as compared with the uninoculated at Kirki was, if we leave out of account the epidemics of the Byculla and Umarkhadi Jails, where there were no deaths, inferior only to the figure obtained at Lanauli and Undhera, and to that set down for Hubli. Hence, although the vaccine used at Kirki is said to have been below the average strength in its power of producing temperature reaction in the inoculated, yet, assuming always the accuracy of the data, it must be considered as being well above the average from the point of view of its efficacy.

In connexion with the relative efficacy of weak and strong vaccines and of larger and smaller doses, Mr. Haffkine has referred, in the case of Daman, first to the better results which are stated to have been obtained in the town by the inoculations performed in March with vaccine which produced a higher fever reaction, as compared with the vaccinations performed in April with vaccine which produced a lower temperature reaction; and further, Mr. Haffkine has referred to the better results stated to have been obtained by Dr. Kalapesi with large doses as compared with the results obtained by Dr. Poiares with small doses. The results as stated by Mr. Haffkine are as follows:—

——	No. of Persons inoculated.	Attacks.		Deaths.		Case Mortality per cent.
		No.	Per cent.	No.	Per cent	
In March, with strong vaccine -	1,017	49	4·8	15	1·5	30 6
After March, with weaker vaccine -	628	41	6·5	20	3·2	48·8
By Dr. Kalapesi, with full doses -	1,924	70	3·6	22	1·1	31·4
By Dr. Poiares, with reduced doses	270	21	7·8	4	5·2	66·7

I. 309.

NOTE.—Mr. Haffkine's figures include persons inoculated more than once.

"Thus," says Mr. Haffkine, "amongst the inoculated with reduced doses the total mortality was 4·5 times and the case mortality 2·1 times higher than that amongst the inoculated with larger doses." Inasmuch as we have already pointed out that figures for the town as a whole must be received with great reserve, we have endeavoured to check the results set forth by Mr. Haffkine by reference to the

I. 309.
Para. 433 of this Report.

investigation sheets prepared by Major Lyons, I.M.S. From these we have taken out all those once-inoculated persons who were inoculated in March, and all those who were inoculated after March. The name of the medical man who performed the inoculations has not been stated in the details supplied in the investigation sheets, but we presume that the inoculations detailed in the third series of investigation sheets, and spoken of as having been done with reduced doses, are inoculations done by Dr. Poiares, and that the inoculations included in the three other series of investigation sheets were done with full doses. The results of our analysis of the investigation sheets is as follows :—

I. 310-30.

——	No. of Persons once inoculated.	Attacks.		Deaths.		Case Mortality.
		No.	Per cent.	No.	Per cent.	Per cent.
In March with strong vaccine - -	87	23	26·6	4	4·6	17·4
After March with weaker vaccine -	167	57	34·0	30	18·0	31·6
With full doses - - -	199	60	30	21	10·6	35
With reduced doses - - -	55	20	36·5	13	22·3	65

The results agree in all important points with those obtained by Mr. Haffkine for the town as a whole. They indicate, as Mr. Haffkine himself has recognised, that it is essential to the attainment of the best results that the vaccine should be carefully standardized.

VII.(5.) *The Comparative Efficiency of Single and Repeated Inoculations.*

Effect of double as compared with single inoculations. Para. 453 of this Report.

467. Closely connected with the question as to what dose of vaccine will give the best results is the question as to what is the comparative efficacy of double and single inoculations. We are able to gather only uncertain indications from the results set down in the first of our synoptical tables. We find that the best results were obtained in Undhera, where only single inoculations were employed. On the other hand, the least favourable results included in the table are those which were obtained among the troops at Bangalore, who were, for the most part, inoculated twice. In short, the figures of the table tend, on the whole, to show that a single inoculation is more effective than a double inoculation. To test this we have collected such additional information as we have been able to extract from the evidence recorded in our Proceedings. That information is summarised in the following table :—

I. 310-30.
23,727.
1771.
Para. 439 of this Report.
III. 404-6.
23,694-5.
I. 429-38.

PLACE.	Number of People under Observation.		Percentage of Attacks among		Percentage of Deaths among		Percentage of Case Mortality among		Ratio of Attacks among the Once Inoculated to Attacks among an equal Number of Twice Inoculated.	Ratio of Deaths among the Once Inoculated to Deaths among an equal number of Twice Inoculated.	Ratio of Fatality in Attacks among the Once Inoculated to the Fatality in an equal number of Attacks among the Twice Inoculated.
	Once Inoculated.	Twice Inoculated.	Once Inoculated.	Twice Inoculated.	Once Inoculated.	Twice Inoculated.	Once Inoculated.	Twice Inoculated.			
Daman (investigation sheets).	254	128	31·5	8·6	13·4	1·5	42·5	18·2	2·3 to 1	3·6 to 1	9 to 1
Gadag (Mr. Foy's figures)	2,528	6,868	1·3	1·5	·5	·7	42·5	44·2	·9 to 1	·9 to 1	·7 to 1
Dharwar (Miss Corthorn's figures).	3,270	3,463	1·7	·6	·6	·2	33·3	28·6	1·2 to 1	2·8 to 1	3 to 1
Hubli (Mr. Cappel's figures for 5 weeks).	9,514	13,453	—	—	·5	·5	—	—	—	—	1 to 1
			Patients admitted.		Number of Deaths.						
Khoja Plague Hospital (Mr. Khaja Adbulla's figures).	—	—	35	27	17	7	48·7	26·0	—	—	1·8 to 1
Gadag Plague Hospital (Mr. Foy's figures).	—	—	32	75	15	41	47·0	59·7	—	—	·8 to 1
Dharwar Plague Hospital (Mr. Hornabrook's figures).	—	—	157	50	53	26	34·0	52·0	—	—	·6 to 1

A scrutiny of this table will show that the results are most divergent. It will be seen that in Daman a second inoculation conferred considerable additional protection. The same appears to hold true, though to a less extent, of patients treated in the

Khoja Hospital at Bombay. From Miss Corthorn's figures for the town it appears that a small amount of additional protection accrued to the doubly inoculated at Dharwar, but Mr. Hornabrook's figures, regarding 157 of the cases observed by him, indicate that the fatality among the twice-inoculated was one-third greater than the fatality among the once-inoculated. Mr. Foy's figures for the town and for the hospital of Gadag similarly show that the twice-inoculated as compared with the once-inoculated were less effectively protected. Lastly, in Hubli the figures regarding deaths set down for the town indicate that there was no difference between the once and the twice inoculated.

If we are to seek an explanation for these divergent results, it is manifest that we can seek it only in the varying strength of the vaccine. We have already pointed out, in the earlier portion of this Chapter, not only that plague cultures of very varying virulence were employed for the preparation of the vaccine, but also that the prescribed dose of the vaccine contained, in some cases, seven times more of the effective bacterial sediment than it did in other cases. We think that differences in the strength of the vaccine may, in addition to explaining the differences set forth in the table we have last given, also account for many of the differences set forth in the synoptical tables. There would, so far as we can see, appear to be a particular dose of vaccinating material which gives the best results, and it would appear to us to be important to secure by the adoption of an accurate method of standardization that this quantum should be contained in the prescribed dose, and that, if possible, this quantum should be administered in a single inoculation, so as to avoid the necessity for re-inoculation.

Section II.(4) of this Chapter.

VIII.—Question of the Duration of the Protection against Plague afforded by Inoculation with Haffkine's Vaccine.

468. We have now reached a point at which it is appropriate to discuss the duration of the protection afforded by inoculation. There are no data to enable us to arrive at a conclusion on this matter, unless we regard as such Major Bannerman's figures for Undhera, which seem to show that the protection had not decreased in the course of six weeks, the figures for the Umarkhadi Jail which show that the inoculated suffered more than the uninoculated in a period dating from the fourth week after inoculation, and lastly (if these can be considered sufficiently accurate to furnish a general indication) the figures for Hubli, Dharwar, Gadag, Bangalore and Mysore. The figures for the five places last mentioned show that the inoculated as a body, though numbers of them were exposed to plague for a considerable time after inoculation, suffered less than the uninoculated, and they may thus be taken as indicating that the effect of inoculation is to some extent lasting.

Duration of protection conferred by inoculation. 4045.

Paras. 437, 439, 440, 441, and 445, of this Report.

From the above it will be seen that the statistics placed before us afford us little material for a decision as to the duration of the protection conferred by inoculation, but this question could be easily determined by following up the history of a group of persons all inoculated at the same time, and by noting the number of cases and deaths from plague among them in a succession of months following upon their inoculation. In interpreting the information thus collected it would be necessary to take into consideration the variation in the amount of plague among the uninoculated population during the months included in the period of observation. While the consideration of the attacks and deaths alone would give us an indication with regard to the duration of protection, more accurate conclusions would probably be drawn if the case mortality was taken into consideration. Just as in the fact that the case mortality among the inoculated in the first days after inoculation is greater than in the succeeding period we have an indication that protection conferred by inoculation is not fully achieved during the first few days, so it is probable that we should find in an increase of case mortality an indication of the time when the protection was beginning to wear off. If two or more groups who had been inoculated with different and accurately known quantities of vaccinating material were kept under observation, valuable indications could probably be drawn from the results as to the quantity of vaccine which produced the most lasting protection.

IX.—Question whether Haffkine's Vaccine exerts any Influence on Diseases other than Plague.

469. Only one question now remains to be dealt with in connexion with the influence on the organism exerted by Mr. Haffkine's anti-plague prophylactic fluid. This question relates to the suggestion, to which we have already referred, that anti-plague inoculation

Question whether anti-plague inoculation exerts influence on other diseases.

I. 338.
Paras. 436 and 446 of this Report.
198-9.
4872, I. 400, 14,824-7, 17,916, 17,963, 19,055, 22,402, 25,459

protects not only against plague but also against other diseases. This suggestion emanated from Mr. Haffkine. It appears that in the course of his inoculation work a certain number of cases were brought to Mr. Haffkine's notice in which fevers of an undetermined nature were favourably influenced by the injection of his vaccine. An idea that anti-plague inoculation might possibly protect against other diseases having thus suggested itself to him, Mr. Haffkine proceeded to seek in this idea an explanation for the extraordinary absence of mortality from general causes which was noted in the case of the Khojas inoculated in Bombay. We have, however, pointed out that the exceptionally light mortality recorded for the inoculated Khojas is capable of being explained in quite a different way. What we have just said applies not only to the case of the Bombay Khojas but also to the case of the inoculated Karachi Khojas, among whom there was a similar extraordinary absence of deaths from general causes, which was similarly attributed to the effects of inoculation. The instances which have been just referred to constitute the only statistical evidence which has been brought forward in support of Mr. Haffkine's claim that his vaccine favourably influences diseases other than plague. As this statistical evidence is untrustworthy, we have to fall back on *à priori* considerations, the two isolated instances which Mr. Haffkine has adduced of cases of fever favourably influenced by inoculation, and a few other isolated instances adduced by other witnesses. According to the more or less indefinite statements of the two or three witnesses who are in question, the plague prophylactic is capable of favourably modifying every possible class of disease, from ringworm to leprosy. It is obvious that statements of this kind are not deserving of serious attention. That vaccination against one disease may influence the course of another is, however, *à priori* quite credible, inasmuch as it is known that one disease may influence the course of another. But since no trustworthy evidence has been adduced before us to show that this obtains in the case of anti-plague inoculation, the suggestion, though one that might be kept in view by future observers, need here no longer engage our attention.

X.—SUMMARY OF CONCLUSIONS REGARDING EFFICACY OF HAFFKINE'S VACCINE.

Summary of conclusions regarding protective effect of inoculation.

470. As a preliminary to discussing the application of inoculation as a measure for combating plague, it will be convenient to summarise here the results of the preceding critical study of the nature and effect of the anti-plague vaccine. These results may be summarised briefly as follows :—

I. Inoculation sensibly diminishes the incidence of plague attacks on the inoculated population, but the protection which is afforded against attacks is not absolute. On the one hand, plague has attacked persons who have undergone inoculation as many as four times in the course of two years previous to their attack. On the other hand, as many as 8 per cent of the inoculated population may suffer from plague, as was the case in Bulsar. Many varying influences have been at work in determining the rate of attack in different places, and it is impossible to give a numerical expression for the measure of protection against attack which inoculation confers.

II. Inoculation diminishes the death-rate among the inoculated population. This is due not only to the fact that the rate of attack is diminished, but also to the fact that the fatality of attacks is diminished. Here, again, no numerical expression for the amount by which the death-rate is diminished can be given.

III. Inoculation does not appear to confer any great degree of protection within the first few days after the inoculation has been performed. This fact, we may note in passing, has an important bearing on the risk of infection which would be incurred by recently inoculated persons if they were left behind in surroundings so plague-infected as to render their evacuation by the uninoculated desirable.

IV. Inoculation confers a protection which certainly lasts for some considerable number of weeks. It is possible that the protection lasts for a number of months. The maximum duration of protection can only be determined by further observation.

V. The varying strength of the vaccine employed has apparently had a great effect upon the results which have been obtained from inoculation. There appears to be a definite quantum of vaccinating material which gives the maximum amount of protection; and provided that this quantum can be injected in one dose, and provided also that the protection turns out to be a lasting one, re-inoculation might with advantage be dispensed with. The best results of inoculation will only be obtained after an accurate method of standardization has been devised.

XI.—CONSIDERATION OF THE POLICY OF THE EXTENDED USE OF INOCULATION AS A PLAGUE MEASURE.

Reason for dislike and opposition of the people towards inoculation.

471. The utility of inoculation as a practical measure depends, above all things, upon the extent to which the people are willing to submit to the operation In a country like India compulsion in such a matter is not to be recommended. The attitude of the people towards inoculation is therefore deserving of very careful consideration. *The attitude* of the people towards inoculation has generally been the reverse of *encouraging*. Though, at times, some of the better classes may have been ready to submit to it, the feeling amongst the masses, at any rate until the good results of inoculation caused influential persons to be inoculated, has generally been one of dislike and opposition. This dislike and opposition, so far as we are able to gauge the reasons for it, was based upon the following objections:—First, there was an unwillingness on the part of the people to undergo the personal inconvenience and fever caused by inoculation, in view of the doubts which they entertained regarding the reality and duration of the protection said to be conferred. Secondly, there was, as we have been told by Colonel Weir, I.M.S., the fear of communication of disease by the syringe from one person to another. Thirdly, in one case at least, at Guntakal, the people were afraid to be inoculated, because a case of sudden death after inoculation occurred in a man previously to all appearances perfectly healthy. Fourthly, we have an instance in Hulsar of a community which refused to avail itself of inoculation because they saw that plague cases continued to occur in a large number (8 per cent.) of a group of inoculated persons which was directly under their observation. Lastly, we have reason to believe that, particularly in Bangalore and Bombay, the progress of inoculations was checked by a statement made in evidence before us to the effect that the prophylactic fluid was very seriously contaminated with putrefactive, and in some instances pathogenic, organisms.

7533, 9211, 9803, 15,434, 18,594, 22,155, 23,398, 23,746, I. 469, I. 476.

921.

919.

5068.

Para. 412 of this Report.

Degree to which inoculation resorted to in places threatened, but not actually infected.

472. This being the feeling of the populace towards inoculation, they have seldom come forward to undergo it, except where they were in imminent fear of something that they disliked still more, and which they hoped by means of it to escape. It has usually been not so much the disease itself as the removal to hospital, segregation, restrictions on travelling, evacuation, and other measures resorted to to check disease, that have induced them to resort to inoculation. Thus, where there was no immediate prospect of measures, there was hardly any inoculation.

The Director-General of the Indian Medical Service, when asked whether he thought the people will ever consent to be inoculated on a large scale before there is an outbreak of plague among them, replied that he did not: "You have only to look at the way in which they neglected vaccination. They admit the effectiveness of vaccination, but they will be apt to neglect it." The Sanitary Commissioner of the Madras Presidency was of the same opinion. "The practical difficulty," he said, "seems to me to be to get an operation of that sort accepted, especially by certain classes of the people and the uneducated generally, in time to secure a prevention of the spread of the disease, that is to say, I do not think it is possible, it is not within the practical sphere of sanitation, to say that any area can be so prepared beforehand (by means of inoculation) as to prevent an invasion of plague." Practical experience in various uninfected places not exposed to any immediate danger seems to prove the correctness of these views. Madras City is a case in point. It has hitherto escaped from indigenous plague altogether, and towards the close of 1898 there was no infection even near it. Major Bannerman, I.M.S., gave a number of lectures there on the subject. He was assisted by three medical officers specially deputed for the purpose; four district surgeons, and a lady doctor also aided him in attempting to popularise inoculation. The net result was that in 2½ months about 5,600 people were inoculated out of a population of 450,000.

7881.

3872.

3,872.

Madras City was not in any immediate danger of infection. In a place which, though still free, is practically certain to be infected at a very early date, the motives for being inoculated may be expected to be stronger. Such a case is that of Mysore City. The motive for all the people getting themselves immunized beforehand was probably as strong in Mysore City as it is ever likely to be in any place, since it was almost certain that the infection would come there from Bangalore. Yet, when the disease 23,504. did come into Mysore City, it found about six-sevenths of the people still uninoculated. 25,106-9. The one advantage to be gained by inoculation in Mysore City was that inoculated persons could travel more readily than the uninoculated. There was no special exemption that the Government could offer to the people, for there were practically no plague measures. Therefore, putting aside a certain number who were inoculated probably because they wanted to leave the town, the majority became inoculated presumably because they believed that they were being protected. The circumstances of Mysore City, however—situated as it is in a Native State—are special, and we have no exact information as to the motives which there induced people to come forward for inoculation before the outbreak was severe, and to cease to submit themselves to inoculation at about the time when plague was at its height.

Except Mysore City, the only place of which we have information that any large proportion of the people were willing to get themselves inoculated before plague broke out among them is Palewal, a small village in the Punjab. It would have been possible, Captain Clarke, I.M.S., told us, to inoculate all the inhabitants of this village. 10,723-8. "There was a Banniah who took the thing up, and he was anxious to remain in and not to be turned out, because it was the beginning of the rains . . . . The people had seen plague all round them, and they themselves stood alone. It was the last village—a little island surrounded by plague villages—and they had seen the discomforts that the others were subjected to . . . . and they were anxious to get relief from those measures. They thought that if they were inoculated they might be allowed to stop in." Here it is obvious that the chief motive for resorting to inoculation was the desire to avoid the ordinary plague measures, and further it is probable that even that motive would not have had much effect had it not been for the influence brought to bear on the people by a prominent inhabitant of the village who was particularly interested in avoiding evacuation.

In other threatened villages in the neighbourhood of towns where inoculations had been carried out on a large scale, the motives that induced the inhabitants to have themselves inoculated may have included, in addition to the motives referred to above, 1961. a conviction that inoculation really did protect against plague. The villagers in the neighbourhood of Hubli and Dharwar were, Mr. Cappel told us, very anxious to be inoculated. The inoculation measures in these two towns had been on such a large scale, and had gone on with advantage to the inoculated for so long, that the people round had been thoroughly convinced of the protection conferred by inoculation. "From one village a long way south of Hubli, I," says Mr. Cappel, "had an offer from a native banker to produce 500 people for inoculation and pay all the expenses of the English Commissioned inoculating officer and his staff. I had another application from the basket weavers of a village 22 miles south of Hubli, who offered to come in in a body to Hubli if we promised not to segregate them, or put them in health camps—a promise which I gave them. There is another village called Annigerry which has frequently applied to me by telegraph and otherwise for the assistance of inoculators, and, that village being a large one, we have treated it as a town, and given it the benefit of inoculation."

Only a few instances like the above have been brought to our notice. On the other hand, we may notice that village opinion is not always influenced by the success of inoculation in neighbouring places. We have a striking illustration of this in II. 517(R.). the case of the villages of the Baroda State. Here, in spite of the fact that the inoculation experiment carried out at Undhera proved so successful, we find that only a very small number of the inhabitants of actually infected villages accepted the offer of inoculation which was made to them. The number who did so in villages threatened but not infected was so small as to be insignificant.

Degree to which inoculation resorted to in places actually infected with plague.

473. Even after plague has attacked a place, inoculation has not made much way with the people, unless in cases where severe plague measures were enforced in the case of the uninoculated and were relaxed in the case of the inoculated. The indifference or opposition of the people towards inoculation is illustrated by the attitude of the people in the two largest cities in India. I. 469. In Calcutta, in the first epidemic, "they 7532-3. made things very unpleasant for persons who were supposed to be inoculators." Dr. Kailas Chandra Bose told us he tried to induce people to be inoculated, but without success. He said, "they are deadly against it, I do not know why. I do not think they would submit to that process at all." The amount of inoculation done was altogether insignificant. Operations were begun the very day that the existence of plague was notified, viz., 30th April 1898. But up to the 22nd July 1898, the

total number of inoculations performed was only 2,490, a number that did not go 6557, 6640.
any appreciable way towards protecting the population. It is true that there were
only two inoculators at work, but if there had been more it would not, in the opinion 6645–6.
of Dr. Nield Cook, the Health Officer, have made any appreciable difference. The
leaders of the Muhammadan community did indeed come forward, and a few of the
better class people of all communities. But inoculation "did not get really taken up: 6643.
the plague did not get quite bad enough." The bulk of those who offered themselves 6650.
for inoculation were "persons who desired to travel by rail without suffering the 6537.
inconvenience of detention at inspection camps." And during the remainder of the
year, owing to the small amount of plague, the absence of scare, and the removal of
the office to another place, the number seeking inoculation rapidly became smaller
still; only 31 persons presenting themselves in a space of five months.

In Bombay City, the number inoculated in 1898 was very small relatively to the
total population. The Municipal Commissioner endeavoured to get the influential 1363.
leaders among the Hindus to co-operate. Small payments were allowed to poor
people who were prevented by the reaction from going to their ordinary work; and
encouragement to perform inoculations was given to the Medical Officers of the
Municipality and to certain private practitioners. But from the beginning of the
year up to 26th November only 25,358 people were inoculated. Lieut.-Colonel Weir, 1366.
I.M.S., told us in December that the opposition was certainly much less than it had 922.
been; and he anticipated that during the next outbreak a very much larger number
of people might come forward. From returns lately sent to us, however, we find that,
although the people of Bombay have had experience of three outbreaks, the number
inoculated up to 13th September 1899 was only 38,454 out of a population of over
800,000. Moreover, of these a considerable percentage consisted of persons inoculated
in the Khoja community, which resorted to inoculation principally on account of the
influence of their Chief, His Highness the Aga Khan.

The case of Karachi is precisely similar to that of Bombay. A very small proportion Para. 446 of this
of the general population of Karachi submitted themselves to inoculation, while a Report.
very large proportion of the Khojas got themselves inoculated. In Broach it would 15,511, II. 522–3.
appear that while the general population did not avail themselves to any extent of
inoculation, the influence of the Parsee Panchayat was able to induce most of the
Parsee community of the place to become inoculated. In the Punjab, where inocula- 10,172.
tions were resorted to, they seem, as in particular at Banga, to have been resorted to
chiefly on account of the advice and example of influential people who interested
themselves in the matter.

In Satara, Belgaum, Surat, and the Central Provinces, where few inoculations were
done, the attitude of the people towards inoculation may be gathered from the
following extracts, to some of which we have already referred, of the evidence given
before us by responsible plague officers.

At Satara, "the people," says Captain Thompson, I.M.S., "only resorted to it when 22,393.
we brought statistics before them to prove its great value." But it also appears that
it was only "more or less" voluntarily that the few came forward who did come 22,391.
forward. "Some compulsion was used, that is to say, they had privileges held out
to them if they submitted to inoculation. If they were living in infected places they
were told that unless they became inoculated they would be moved out into segregation
and health camps." "I have tried every means in my power," said Colonel Hay,
also referring to the town of Satara, "to persuade them, even to the extent of
promising re-admission to their houses; they have been promised that those who have
been evacuated should be allowed to return if they would be inoculated, but it has had
no effect on them at all."

The object of the few people who got themselves inoculated at Karad, in the Satara 21,118, 21,123.
district, seems to have been mainly to get permission to go out into the infected
villages for trading purposes.

At Belgaum the people who came up for inoculation came "on the assurance given 23,132.
to them that no inoculated person would be liable to be removed to hospital or segrega-
tion camp against his wish." The withdrawal of that assurance resulted, Mr.
Uchgaonkar says, "in almost a complete check to the further progress of inoculation."

Most of the people inoculated at Surat were, Lieut.-Colonel Nariman, I.M.S., said, 15,879
"Refugees from Bombay, and they wanted to get back to Bombay."

Colonel Hutcheson, I.M.S., again, told us that at Hinganghat, in the Central Provinces, 6046.
the people applied for the inoculations to be done simply in order to obtain a pass which
would permit them to go to their various employments.

9211. In the North-west Provinces, Mr. Winter said, "At Jawalapur arrangements were made for inoculation, but we were to use no pressure on the people, and they would not hear of it."

Conditions in places where inoculations largely resorted to.

474. We may now pass on from the consideration of infected places where inoculations were either not done or were done only in very small numbers, to the consideration of infected places where a considerable portion of the population was inoculated. We have already considered the case of Mysore City, which stands by itself, and we have now to consider only the cases of Hubli, Dharwar, and Gadag, all three within the Dharwar district, and of the City and Civil and Military Station of Bangalore. We have referred above to the question of the general motives which induced people to became inoculated, and we have also in our critical study of the statistics, in the cases of the particular towns now in question, dealt with the motives which were specially operative in them, and the manner in which inoculations were pushed. It may, however, be advisable here further to quote the opinion of some of the officers on the spot.

1963. "The object of the people," says the Collector of Dharwar, speaking of all the towns in his district, but more especially of Hubli, "is, in a very large proportion of cases, and the object of almost all the people at the beginning of the operations before they become convinced by bitter experience of the advantages of the process, is not to obtain an inoculation, but to obtain the certificate, which carries with it certain immunities and privileges."

The motives which influenced the people of Dharwar to get inoculated may be judged also from the following statements. On the one hand, Major Hardy, the Chief Plague Officer of the town, stated the people "feared segregation and inoculation . . . . 18,000 went out in one week influenced by this fear." On the other hand, Surgeon-General Harvey, the Director-General of the Indian Medical Service, in addressing the Royal Society, and, we understand referring to the case of Dharwar, said "that while the mention of inoculation drove 300,000 people from the City of Calcutta, he had himself seen, in another part of the country, people coming in their hundreds to be inoculated, and paying 2 annas each for the privilege." That payment was made for inoculation does not prove that the people appreciated the value of inoculation as a protection against plague, any more than the fact that, in the neighbouring town of Hubli (and we think that this was the case at Dharwar also) payments were made by the people for the disinfection of their houses proves that they had a belief in the efficacy of disinfection. In both places inoculation and disinfection were necessary preliminaries to the return of the people to their houses. 23,746.

23,680. Speaking of Gadag, Mr. Foy, M.B., told us, "With the appearance of plague there was a further rush for inoculation, and a large number were inoculated before the epidemic had taken a very strong hold, and to prevent having themselves evacuated from their homes." And the same witness also said, "The people of Betigeri made a great rush for inoculation, and thus avoided the general evacuation of the town by getting all the inmates of their houses inoculated."

When asked, with regard to the inoculations in Bangalore, whether the protection afforded to them was the only inducement for people to become inoculated there. Captain Leumann, I.M.S., said, "Partially the protection afforded, but chiefly, I think, to escape segregation." 3184, 3170.

Importance of encouragement, of inoculation, by influential members of the native communities of India.

475. It appears, then, to us to be evident that hitherto at all events the principal motive which has induced individuals to come forward to be inoculated has been the desire to obtain relief from the inconveniences of the plague measures ordinarily applied, rather than that of protecting themselves against an attack of plague. This is a somewhat discouraging conclusion; but we may, perhaps, hope that when the beneficial effects of inoculation are more widely known native opinion may be won over to its favour. Seeing what has been done in certain places by personal influence, like that exerted by H.H. the Aga Khan, we think that influential men in the native communities of India can do much to bring about this more satisfactory state of affairs. It is to be noticed that personal influence is particularly valuable wherever severe plague measures are not applied, and where, therefore, there are no material advantages in the form of a relaxation of measures which can be conferred upon the inoculated, and which can operate as an inducement for people to submit to inoculation. Moreover, the encouragement of inoculation by the personal influence of prominent members of the native communities will render it possible to dispense with such a system as that of encouraging inoculation by the grant of small compassionate allowances, which is liable to abuse.

Considerable time required to inoculate any sensible fraction of population of towns and villages.

476. In view of the fact that the policy of inoculations will give its best results only when inoculations have been undertaken before the advent of plague, or soon after it has broken out, it is important to note that experience in the past has shown that inoculation as a measure is much more easily applied in towns than in villages. A scrutiny of the figures relating to towns where inoculation has been largely resorted to will show that it takes a very considerable time to inoculate any sensible fraction of the population. In only one case, that of Mysore, has such a sensible fraction been inoculated before the outbreak of plague. In the case of villages, the time required is greater relatively to the number of the population, as we can see by a reference to the time which was occupied in the inoculations performed in the villages of the Baroda State, and at Lingdhal and Huilgol, which have been mentioned in a previous part of this Report. Paras. 448 and 442 of this Report.

Effect of inoculation in preventing panic.

477. We have hitherto dealt with the protective effective of inoculation in preventing attacks and deaths from plague, and we must now pass on to consider whether the adoption of inoculation as a measure is likely to have the beneficial effect claimed for it in preventing panic in an infected place with its attendant exodus of the population and consequent dislocation of trade. In this connexion Mr. Cappel, referring to both Hubli and Dharwar, said :—" In Hubli trade was not seriously interfered with at any time, and in Dharwar the course of business has never been interrupted. In Hubli, 1956.
owing to weather conditions, the town was never evacuated on any large scale. In Dharwar about one-third of the people went out immediately on the outbreak of plague. But these people who went out were of the agricultural class, owning land round about, and their families and dependents. The 10,000 people who remained and who were enabled to remain by inoculation alone were the Government employees, the large mass of railway employees, and the business part of the community. There was no interruption to railway business, Government business, or commercial business in Dharwar. That state of things would have been impossible without inoculation, and if inoculation had not been carried out, or if inoculation had failed, the consequence would have been very serious, both in Hubli and Dharwar."

In speaking of Betigeri, Mr. Foy claimed advantages for inoculation similar to those 23,680.
claimed by Mr. Cappel in the cases of Hubli and Dharwar. He said that the people freely resorted to inoculation and " the consequence is that the main street of Betigeri has always presented a busy aspect, the shops remaining open, and some amount of trade is carried on."

Major Richard Baker, I.M.S., as we have already noted, told us with reference to 18,430.
Lanauli that while the uninoculated part of the town was deserted on account of the plague, the inoculated part was full of people.

Regarding the causes of the exodus which took place from Bangalore City, Colonel 3482.
Benson, I.M.S., told us that at the commencement of the outbreak the supply of vaccine ran short. " The result of sufficient vaccine not being available was that a very great number of people ran away from the town who would otherwise have remained." In Mysore City the inoculations, as we have seen, were largely done 24,977-9.
before plague got a hold on the town, and though an exodus took place, it was smaller than that from Bangalore City and the Civil and Military Station.

It is quite plain that panic could only be prevented by inoculation in so far as inoculation prevents severe mortality from plague. In other words, if the people are not inoculated sufficiently early and in sufficiently large numbers, a flight from an infected locality will not be prevented. Where, however, the inoculated have confidence in the efficacy of inoculation, the exodus will be that of uninoculated persons only, and the inoculated will continue to perform their avocations. On the other hand, when people dread inoculation, and fear that it may be insisted on, the adoption of inoculation as a plague policy may, as we have seen in the case of Dharwar and Calcutta, give rise to a far more formidable panic and exodus than any which would have been produced by the fear of plague. In response to a question whether the people of Dharwar would have left the town from fear of the plague, Mr. Cappel told us: " No, none of them would have moved. They would have waited till they were 1614.
nearly all dead. They would have moved out in the next epidemic undoubtedly, but they would not have learned their lesson before." Our conclusion, then, regarding this matter is that people after being inoculated have shown less disposition to fly from an infected place than the uninoculated, but that it is impossible to judge how far this result has been due to the sense of security derived from inoculation, or how far it has been due to the escape from the worries of other plague measures from which, as inoculated persons, they have been exempt.

Conclusions as to feasibility of adoption of inoculation as a plague measure.

✓478. With regard to the feasibility of adopting a general policy of inoculation, our conclusion, based upon the above considerations, may be set forth as follows:—

(1.) Experience gained hitherto has shown that it is very seldom possible to get a large proportion of the inhabitants of an uninfected place inoculated.

(2.) It has been possible, where the inducement of exemption from segregation and eviction has been offered, to get a large proportion of the inhabitants of an infected place inoculated quickly.

(3.) It has been possible in one place, Mysore City, even where no inducement that touched the great mass of the people could be offered, to get a considerable proportion of the inhabitants of an infected place inoculated quickly.

(4.) It has been possible also to induce a large proportion of particular communities, such as the Khojas of Bombay and Karachi, to be inoculated under the influence of their leaders.

XII.—Recommendations regarding the Adoption of Inoculation with Haffkine's Vaccine as a Plague Measure, and Conclusion.

Recommendation regarding adoption of inoculation as a plague measure.

479. Our recommendations are governed by these conclusions, as well as by the conclusions we have already drawn with regard to the protection conferred by inoculation. They are further governed by the consideration that it is necessary, as far as may be possible, to dispel the particular objections on account of which the people have hitherto refrained from inoculation. Moreover, our recommendations are based on the consideration that it is advisable to make the operation as effective as possible, as little inconvenient as possible to the person inoculated, and as easily carried out as possible by the inoculator.

I.—We have already insisted on the necessity for the accurate standardization of the vaccine, as being essential to the attainment of the best results, both as to the protection conferred and as to the duration of that protection. We have pointed out, also, that the introduction of an accurate system of standardization may possibly obviate the necessity of employing two successive inoculations.

II.—With a view to dispelling the natural fears of the people, and avoiding all unnecessary risk to the inoculated, and further, with a view to enabling the inoculations to be carried on with the least possible amount of attendant inconvenience, we would insist upon the necessity that stringent precautions should be taken to insure that all the vaccine used is quite free from contamination, and we would recommend that the volume of the necessary dose should be made as small as possible.

III.—With a view to removing any possible ground for distrust as to the conveyance of disease by inoculation from one person to another, we would recommend that the syringe should be sterilised in the presence of the person about to be inoculated.

IV.—We are of opinion that inoculations, under the safeguards and conditions stated above, should be encouraged wherever possible, and in particular, it seems to us desirable to encourage inoculation among disinfecting staffs and the attendants of Plague Hospitals.

Conclusion.

480. We cannot bring to a conclusion this consideration of anti-plague inoculation by Mr. Haffkine's prophylactic fluid without expressing our sense of the importance of the method which Mr. Haffkine has devised and of the results which have been achieved by it. The credit due to Mr. Haffkine is the greater because the difficulties with which he had to contend in this matter could only have been overcome by great zeal and endurance. Mr. Haffkine's work on anti-plague inoculation, while not based on any new scientific principle, constitutes, it seems to us, a great practical achievement in the region of preventive medicine.

CHAPTER V.

SERUM THERAPEUTICS OF PLAGUE WITH SPECIAL REFERENCE TO THE ANTI-PLAGUE SERA OF YERSIN AND LUSTIG.

I.—Introductory Discussion regarding the Production, Characters and Mode of Action, and Methods of Testing for the presence, of Anti-Toxic and Anti-Bacterial Substances.

I. (1.)—*Principles of Serum Therapathy.*

Serum treatment applied to plague.

481. The discovery (made almost simultaneously by Behring and Fraenkel) that the serum of animals which have been subjected to repeated inoculations of the specific poisons of diptheria and tetanus is capable of functioning as a specific antidote to these poisons is a discovery of the most far-reaching importance, opening up as it does a prospect of effectively treating all bacterial diseases by antidotal substances elaborated in the organism of immunised animals. Our concern here will, however, be not so much with the general therapeutic principle which takes its origin in the discovery of Behring, as with applications of this therapeutic principle which have been made by Yersin and Lustig respectively in connexion with the prophylaxis and treatment of plague. Before dealing with these we may with advantage set before us certain general considerations with regard to the pathological processes, and with regard to the serum treatment, of plague.

Nature of the pathological processes associated with plague and question as to kinds of therapeutic substances required for the treatment of these.

482. In the case of plague, we have to deal with a "combined invasion and intoxication process." In other words, we have to deal, on the one hand, with an invasion of the system by the micro-organisms of plague, and, on the other hand, with an intoxication produced by the poisons of these bacilli. In conformity with this, it is manifest that two different classes of therapeutic substances might appropriately be brought into application in the treatment of plague. In the first place, *anti-bacterial substances* might be brought into application with a view to killing, or checking the growth of, the invading bacteria. In the second place, *anti-toxic substances* might be brought into application with a view to abolishing or alleviating the symptoms which are referable to the bacterial poisons. The fundamental facts with regard to the (*a*) production, (*b*) characters and mode of action, and (*c*) methods of testing for the presence, of each of these classes of therapeutic substances may conveniently be separately discussed.

I. (2.)—*Anti-toxic Substances.*

Question whether anti-toxins are elaborated in the organism for all poisons.

483. Beginning with the anti-toxins we may consider certain questions which suggest themselves in connexion with Behring's discovery that diphtheria and tetanus anti-toxins make their appearance in the blood of animals which have been subjected to repeated inoculations of the corresponding toxins. The first of these questions is as to whether the animal organism which responds to the incorporation of diphtheric and tetanus poisons with a production of anti-toxic substances possesses the potentiality of responding in a similar manner to the incorporation of all other poisons. A moment's consideration furnishes the answer, it being manifest that, if the organism possessed the power of elaborating an anti-toxin to any and every poison, it would necessarily manifest a capacity for tolerating increasing doses of all poisons indifferently. Such a capacity, however, exists only with respect to a comparatively small minority of poisons. Even in the case of this minority of poisons, anti-toxins are not in all cases produced by the incorporation of repeated and gradually increasing doses. It would appear that toleration of alcohol and of morphia does not depend upon the elaboration of any corresponding anti-toxins.

Question whether anti-toxins are obtained exclusively in connexion with bacterial poisons and invariably in connexion with these.

484. The next question which presents itself for consideration in connexion with the production of anti-toxins is the question as to whether anti-toxins are obtained exclusively in connexion with the incorporation of bacterial poisons and invariably in connexion with these. This question may, as regards the former point, unhesitatingly be answered in the negative, for anti-toxins have been obtained, on the one hand, to the non-coagulable neurotropic constituent of snake venom, and, on the other hand, to a variety of poisonous vegetable "albumoses," in particular to ricin, croton, abrin, and robinin. The question as to whether anti-toxins can invariably be obtained by the incorporation of poisons of bacterial origin must also apparently be answered in the negative. In particular, the attempts which have been made to obtain an anti-toxin to the poisons of the tubercle bacillus have proved quite unsuccessful.

Classification of poisons into a class of antitoxi-gennetic and a class of non-antitoxi-gennetic poisons.

What has been said above with regard to the elaboration of anti-toxins in the system may be summed up in the statement that poisons may be distributed into a class of antitoxi-gennetic, or anti-toxin producing, poisons, and into a class of non-antitoxi-gennetic poisons, poisons which do not produce anti-toxin.

Toxins may, after they have been incorporated, circulate as such for a considerable period in the blood.

485. The next question which must engage our attention—for it would lead us too far afield to discuss the brilliant hypothesis with which Ehrlich has illuminated the whole question of the production of anti-toxins within the system—is the question as to the immediate and remote results exerted on the blood by the incorporation of a bacterial poison.

It is important to realise that poisons in general, and, in particular, bacterial poisons, whether these afterwards give rise to a production of anti-toxins or not, may, for quite considerable periods, continue to circulate as such in the blood of the animal into which they may have been incorporated. It was shown by Metschnikoff that this occurs in the case of tetanus toxin introduced into the system of crocodiles and other reptiles. The same observation was made by one of us (Ruffer) in the case of tuberculin introduced into the system of a horse. In the particular experiments in question serum, drawn off from a horse after the expiration of an interval of many weeks from the date of the incorporation of the tuberculin, gave origin, when introduced into the tubercular organism, to a typical tuberculin reaction.

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Sequence of events after incorporation of antitoxi-gennetic poisons.

Ztsch. f. Hyg. XIII., p. 336.

486. The course of events, however, after the incorporation of a poison which ultimately gives origin to a production of anti-toxin is more complex. It may be assumed to be identical with that registered by Ehrlich and Brieger in an experimental investigation directed to the study of the effect produced by the incorporation of tetanus toxin into a milch goat. It was shown in this investigation that in the phase which supervened directly upon the inoculation of the tetanic poison (this phase probably covers the whole period during which the animal is suffering from constitutional symptoms) the milk—and we may assume also the blood of the inoculated animal—exerted upon the animals to which it was administered an effect indistinguishable from that which supervenes upon a direct inoculation of the tetanic poison. Upon this first phase supervened, after a certain interval, a stage in which the milk and blood produced when inoculated into animals neither toxic nor anti-toxic effects. Finally, a stage supervened in which the blood was definitely anti-toxic.

It would thus appear that the blood of an animal which has been subjected to the injection of a bacterial poison may, when it is introduced into the organism of another animal, produce either toxic or anti-toxic effects, according to the period at which the blood has been drawn off, and according as the particular poison may happen to belong to the class of the antitoxi-gennetic poisons, or to the class of the non-antitoxi-gennetic poisons.

Toxic effect may be produced by sera drawn off for therapeutic uses.

487. It is obviously a corollary to the conclusion we have just stated that where a mixture of antitoxi-gennetic and non-antitoxi-gennetic poisons has been incorporated, the blood which is drawn off, while it possesses anti-toxic properties with respect to one class of poisons, may at one and the same time possess also certain toxic properties. In connexion with this particular possibility, we may refer to the fact that, in a series of experiments made by one of us (the President), it was found that animals which had been inoculated with less than the minimum lethal dose of venene succumbed when treated with an anti-toxic blood drawn off from a horse which had been inoculated with snake-venom. Again, in connexion with the general question of the possibility of toxic effect being produced by sera drawn off for therapeutic purposes, we may note that it was found by Dr. W. Bulloch, in a series of experiments of which the results have been privately communicated to us, that the serum of a particular horse which had been treated with staphylo-coccus cultures was lethal to guinea-pigs when administered in doses of over 1 c.c. Dr. Klein informed us that he had had a similar experience. He had observed that the serum of animals which had been treated with cultures of the bacillus sporogenes enteritidis exerted toxic instead of curative effects. In the case of man also definitely toxic effects following on the injection of therapeutic sera have probably come under the notice of every observer who has had any wide experience of serum-therapathy. In particular, toxic effects have come under observation in connexion with the administration of anti-strepto-coccus serum. Such toxic effects, while they are, we are aware, currently ascribed to a toxic influence exerted by foreign blood upon the human or animal organism, may, we think, in many cases, be referable to the introduction into the system of non-neutralised bacterial poisons.

27,353.

488. In connexion with the question of the characters and mode of action of anti-toxic substances, there are two points in particular which we must place clearly before us. The first of these relates to the mode of action of anti-toxins, and to the quantitative relations in which anti-toxins must stand to their corresponding toxins. With regard to this, it has been definitely ascertained that it is essential to the complete achievement of the desired therapeutic effect that the amount of anti-toxin administered shall be in correspondence with the amount of toxin which is to be counteracted; given, in other words, that a unit, such as an ordinary lethal dose, or a multiple of that unit, of toxin is to be counteracted, the neutralisation of that toxin will involve the administration of a corresponding unit, or multiple of that unit, of anti-toxin. This, it will be noted, is in conformity with the assumption established by the researches of Ehrlich, C. J. Martin, and one of ourselves (the President), that anti-toxins are toxitropic substances, that is, substances which enter into direct chemical combination with their corresponding poisons. It must be clearly understood that the toxin and anti-toxin inter-act with each other in accurately determinable quantitative relations only in cases where the anti-toxin is brought directly into relation to the toxin before it is injected, or where, failing this, the anti-toxin is incorporated either before or immediately after the injection of the toxin; in other words, the proposition, that the toxin and anti-toxin inter-act strictly in accordance with the law of chemical equivalents, applies only in cases where the conditions are such that the anti-toxin can operate upon the corresponding poison before this poison has entered into chemical combination with the protoplasm of the body cells.

Mode of action of anti-toxins is by direct combination with their corresponding toxins, the reaction being a strictly quantitative one where the two classes of substances are brought directly in contact with each other.

489. A principle, quite other than that of combination in accordance with the law of chemical equivalence, comes into operation when the anti-toxic substance is introduced into the body at a period when the toxin has already entered into chemical combination with the body cells. Under these conditions the chemical, and in consequence the therapeutic, event would appear to depend entirely upon the anti-toxin being incorporated in sufficient quantity, and in such a manner, as to bring it in relation with the poisoned tissue in a sufficiently concentrated form. In other words, a favourable therapeutic result would appear to be achievable only when the mass effect of the anti-toxins which come actually into relation with the poisoned cells is sufficiently great to effect the dissociation of the toxin from the combination into which it has entered with the poisoned cellular protoplasm. Only when the dissociation in question has been effected will the cell protoplasm be again free to resume its normal functions. The conditions necessary for the achievement of the result would, as consideration will show, be realisable either by the injection of moderate doses of a concentrated anti-toxin directly into the poisoned tissue, or, failing that, by the injection of enormous doses of the concentrated anti-toxin directly into the blood stream, provided always that the anti-toxin, after it had passed out into the lymph, was afterwards led in a continuous stream through the poisoned tissue. Inconsistent with the success of the anti-toxin treatment in the cases under consideration would be, on the one hand, the employment of doses of anti-toxin too small to confer anti-toxic properties on the lymph, and, on the other hand, a stagnation of the lymph stream in the poisoned tissue.

Where the toxins have already entered into combination with the tissues a process of dissociation must first take place.

490. We pass to the consideration of the methods by which the presence of anti-toxins in a serum can be determined in a quantitative manner.

Methods of testing serum with a view to ascertaining whether it does or does not contain anti-toxic substances.

The first point which invites attention relates to the form in which the test-toxin shall come into application. In connexion with this it must be borne in view that it is essential to the correct carrying out of the test that the poison which is employed shall in every case be incorporated into the animals experimented upon in a dissolved as distinguished from a particulate form. Metschnikoff, in particular, has pointed out that, when the toxin employed for the test is contained in the body of bacteria instead of being free in solution, fallacies in judging of the results of the action of an anti-toxin may readily arise in consequence of the intra-cellular destruction of the poison in the interior of phagocytic leucocytes.

Test-toxin to be administered in a dissolved as distinguished from a particulate form.

A second point relates to the possible admixture of extraneous poisons with the test-toxin. In this connexion the toxic properties of peptone broth come into consideration as possible sources of fallacy. It is obviously possible where, as in the case of filtrates from plague cultures, we may be dealing with comparatively small quantities of bacterial poisons admixed with very considerable quantities of peptone broth that the fate of the animal experimented upon may depend quite as much, if

Test-toxin to be free from admixture with extraneous poisons.

not more, on the neutralisation of the toxic element of the broth as upon the neutralisation of the bacterial toxins.

Test-toxin to be administered in large multiples of a lethal dose.

The third point relates to the quantum of the specific poison which ought to be administered in test experiments. It will not suffice to ascertain the minimum lethal dose of the test poison, and then to employ that minimum lethal dose as the test dose. The fallacies incident to such a method will be obvious when we consider that, if a test dose of toxin consists only of a simple minimum lethal dose, the animal experimented upon will survive the test inoculation even in the case where the quantum of serum employed neutralises only a small fraction of the incorporated toxin. It is obvious that, if in such a case the survival of the test animal were taken as evidence of the efficacy of the serum, an altogether fanciful value would be ascribed to that serum. With a view to avoiding the fallacies incident to all experiments where the test dose of toxin corresponds only to the minimum lethal dose, it is now an accepted principle that the test dose of the poison shall in every case correspond to a multiple, and wherever possible, to a very large multiple, of the minimum lethal dose. It may not be superfluous to make clear the advantage which results from compliance with this last provision. This may, perhaps, best be done by means of an example. If, for instance, we take as our test dose of poison a quantum which corresponds to two minimum lethal doses, and if we then find that a particular addition of serum suffices to avert a fatal issue from our test animal, we have manifestly proof of the efficacy of the serum. At the same time we are still left in doubt as to whether the quantum of poison which has been neutralised corresponds to two complete minimum lethal doses, or whether it corresponds only to a fraction more than one minimum lethal dose. We are thus admitting into our quantitative estimation of the amount of anti-toxin present a possible error of something like 50 per cent. When, on the contrary, we take as our test dose a quantum of toxin which corresponds to 100 lethal doses, and when we then find that a particular addition of serum suffices to avert a fatal issue from our test animal, we are plainly entitled to infer that the serum must have neutralised, at least, 99 minimum lethal doses. In other words, we reduce the error in our estimation within the limit of 1 per cent.

These points relative to anti-toxins having been disposed of, we pass to the consideration of the anti-bacterial substances.

I. (3.)—*Anti-bacterial Substances.*

Definition.

491. The term "anti-bacterial substances" is often employed in bacteriological literature in a very loose sense. It is frequently there employed in such a manner as to include all sorts of stimulating and nutrient substances, which may, by indirect means, enable the organism to offer a more effectual resistance to bacterial invasions. We propose to deal here, under the heading of "anti-bacterial substances," only with substances which have direct or indirect bacteriotropic affinities, *i.e.*, only with substances of which it can be shown that they exercise a chemical influence upon bacteria.

Discrimination of anti-bacterial substances into a class of stable and specific and of unstable and non-specific substances.

Ztsch. f. Hyg. IV., p. 339.

492. We may begin our consideration of the character and mode of action of anti-bacterial substances by emphasising the fact that there appear to be two distinct classes of such substances. We have, on the one hand, a class of non-specific anti-bacterial substances which apparently exert an influence indiscriminately upon all bacteria. These are characterised by their great instability. They are destroyed, as was first shown by Nuttall, working under Flügge's directions, when they are exposed to a temperature of 55° C.; further, they are destroyed by exposure to sunlight; and, lastly, they are spontaneously destroyed when the serum in which they are incorporated is allowed to stand for a period of days or, as the case may be, of weeks after it has been drawn off. We have, on the other hand, a class of anti-bacterial substances which exert a specific effect each, it would appear, only upon its corresponding species of bacteria. Unlike those which have been already considered, these substances appear to be comparatively stable bodies. In particular they are not destroyed by the exposure to a temperature of 55°; neither are they destroyed when the serum is allowed to stand for prolonged periods after it has been drawn off; lastly, they are not readily broken down under the influence of sunlight, or of ordinary putrefactive micro-organisms.

Probable mode of action of stable anti-bacterial substances.

493. Passing to the consideration of the mode of action of anti-bacterial substances, it will be convenient to take up first the question of the mode of action of the specific anti-bacterial substances. When a specific anti-bacterial substance is brought in

contact with the particular species of bacteria which it is capable of affecting, it is to be assumed that a chemical combination takes place between the anti-bacterial substance, on the one hand, and some one of the constituent elements of the bacterial protoplasm, on the other hand. The conditions under which the chemical combination in question will take place are probably analogous to those considered above in the case of the anti-toxins. We saw in connexion with these, that, when an anti-toxin is brought directly into relation with its corresponding toxin, a chemical reaction takes place, which, in the case where the toxin is free, consists, it would appear, in a simple chemical combination of the anti-toxin with its equivalent of toxin. We saw further that when anti-toxic substances come into effective operation, in the case where the cellular protoplasm already is occupied by poison, the eventual chemical reaction which takes place is apparently somewhat as follows: first, under the influence of the mass effect which is exerted by the anti-toxin, the poison is dissociated from its combination with the poisoned protoplasm; following upon this dissociation, a chemical combination takes place between the anti-toxin and the toxin which has been withdrawn from the cellular protoplasm. Manifestly it will be to this complex chemical reaction, rather than to the simpler reaction which obtains between anti-toxins and free toxins, that the chemical reaction between anti-bacterial substances and the constituent element of the bacterial protoplasm is analogous. In other words, the combination of the anti-bacterial substance with the corresponding constituent of the bacterial body must be ushered in by a disruption of the bacterial protoplasm. If that disruption is a fundamental one, the anti-bacterial substance will by virtue of that disruption exert bactericidal effects. If, on the contrary, the disruption which takes place in the bacterial protoplasm is a comparatively superficial one, such, for instance, as the disruptive effect which is exerted by an agglutinin, the anti-bacterial substance will exert on the bacteria at most an influence in restraint of growth.

A word or two may here be appropriate in connexion with the forces which oppose the disruptive forces which are brought to bear by the anti-bacterial substances on the bacterial protoplasm. Manifestly these forces are represented by the chemical forces which hold together the bacterial protoplasm. These cohesive forces are, we may assume, relatively powerful in the case of virulent bacteria—virulent bacteria being by definition bacteria which are endowed with a capacity of preserving their vitality in an organism. In like manner the chemical forces which hold together the bacterial protoplasm may be assumed to be relatively weak in the case of attenuated bacteria, these being bacteria which are ill adapted to resist the destructive forces which come into operation upon them in the animal organism.

Probable mode action of non-stable anti-bacterial substances.

494. In connexion with the mode of action of the non-specific anti-bacterial substances, it appears to be certain that these substances, which are contained in the freshly drawn blood of every normal animal, are of altogether fundamental importance in connexion with the destruction of bacteria in the organism. We have proof of this in the fact that the bactericidal and bacteriolytic effects which are obtained when bacteria are brought into contact with the stale blood of immunised animals are much less pronounced than the bactericidal and bacteriolytic effects which are obtained when the same bacteria are brought into contact either with the freshly drawn blood of immunised animals, or with the stale blood of immunised animals which has received an addition of freshly drawn blood derived from normal animals. The explanation of this fact presents many difficulties. It has been suggested, on the one hand, that it is the non-specific anti-bacterial substances which alone are really active, and that they exert an action similar to that of the digestive ferments, the specific anti-bacterial substances playing merely the part of mordants which bring the non-specific anti-bacterial substances into chemical relation with the bacteria. It is, on the other hand, possible that the added effect which is obtained when non-specific anti-bacterial substances operate in conjunction with the specific anti-bacterial substances may be attributable to the combined effect of disruptive forces coming into operation upon the bacterial protoplasm simultaneously in opposite senses.

Conditions under which an anti-bacterial action will come into operation upon bacteria in the tissues of the infected organism.

495. The conditions which must be satisfied before the disruptive forces exerted by the anti-bacterial substances can come into operation on bacteria in the tissues of the infected organism are entirely analogous to the conditions which must be satisfied before the anti-toxins can in the poisoned organism affect the dissociation of toxin from the cellular protoplasm with which it has combined. In other words, the anti-bacterial substances must, before they can affect the bacteria which are situated in the tissues, pass into the blood and thence pass out into the lymph. Further, the lymph which has thus acquired anti-bacterial properties must be led in

a continuous stream through the organs or tissues which harbour the invading bacteria. Lastly, the therapeutic efficacy of the anti-bacterial substances can make itself felt only in cases where the mass effect which is achieved in the poisoned tissues is adequate to bring about the desired disruption in the bacterial protoplasm. It may be noted that the difficulties which stand in the way of the realisation of these conditions constitute perhaps a more formidable obstacle to the effective therapeutic exploitation of anti-bacterial substances than even the difficulties which are associated with the production of potent anti-bacterial sera.

Conditions under which anti-bacterial substances make their appearance in the blood.

496. With regard to the nature of the chemical stimulus which gives rise to an increase of anti-bacterial substances in the blood, the salient fact which we have to place before us is that, so far as is known, such increase occurs only after the incorporation of either living or dead bacterial cultures. In view of the fact that the bacteria which are introduced into the system of the inoculated animals are there disintegrated, we may infer that the actual chemical stimulus which comes into operation, and which gives origin to the production of the anti-bacterial substances, is the stimulus which is exerted by the poisons which are set free on the dissolution of the bacterial protoplasm. It would thus appear that the conditions under which the specific anti-bacterial substances originate are identical with those under which anti-toxic substances originate. The anti-bacterial substances have, further, this point in common with the substances to which the term anti-toxins is usually restricted, that they make their appearance in the blood only after a not inconsiderable interval has elapsed from the time of the incorporation of the corresponding poisons.

Method of testing a serum with a view of ascertaining whether it does or does not contain any anti-bacterial substances.

497. Three different kinds of methods can be employed with a view to determining whether a particular serum contains any anti-bacterial substances.

1. The serum may be mixed in vitro either in the diluted or undiluted state with the bacteria against which it is to be tested. Microscopic observations may then be made to determine whether the morphological structure or disposition of the bacteria is in any way altered by the serum. This will be a perfectly simple matter where we are dealing with motile bacteria, and with bacteria which do not, in the ordinary course of growth, agglomerate themselves into groups; if agglutinins are contained in the serum, the presence of these will be notified by the fact that bacteria will lose their motility and will be agglomerated.

2. Further, the effect of the serum upon the bacteria may be judged of by cultivation methods. We may determine, on the one hand, whether the bacteria will grow in the serum, and, on the other hand, whether all or a large proportion of the bacteria which are brought in contact with the serum are thereby killed or rendered incapable of growing when transferred to ordinary nutrient media.

By the employment of the above methods we are enabled to form some anticipation with regard to the effect which the serum would exert if it were brought into direct contact with the bacteria in the infected organism.

3. Further, a serum may, in conformity with the method of Pfeiffer, be tested for the presence of specific anti-bacterial substances by introducing it into the peritoneal cavity of a normal animal along with a measured quantity of the corresponding bacteria. The presence or absence of specific anti-bacterial substances would then be judged of by withdrawing portions of the peritoneal fluid at different intervals and examining them, with a view to ascertaining whether the bacteria which were incorporated have been spherulated or dissolved.

By the application of this method, we obtain information as to the effect which the serum would be capable of exerting when introduced into an infected organism, which had at its disposal the same resources in the form of non-specific anti-bacterial substances as are at the disposal of the normal animal.

4. Lastly, the presence of anti-bacterial substances in a particular serum may be judged of by ascertaining whether a favourable therapeutic result is obtained by the introduction of this serum into an animal which has been infected with the disease which the serum is designed to counteract.

By the employment of this method we obtain definite information as to what may be hoped for from the therapeutic application of the serum.

II. METHODS EMPLOYED IN THE PREPARATION OF THE ANTI-PLAGUE SERA WHICH HAVE BEEN USED IN INDIA.

The preparation of anti plague sera.

498. Having now completed our prefatory task, we take up at this point the consideration of anti-plague sera, which form the special subject-matter of this portion of our Report. Under the heading of "Yersin's anti-plague serum," we shall deal with all sera prepared by the incorporation into animals of living or dead cultures of the plague bacillus.* Similarly, under the heading of "Lustig's anti-plague serum," we shall deal with all anti-plague sera prepared by the process of Lustig.

Our consideration may conveniently begin with the preparation of the sera in question.

Method of preparation of Yersin's serum.

499. It will not be possible in connexion with the preparation of Yersin's serum to do more than indicate generally the procedure which was followed in the case of the serum which was placed at our disposal by the authorities of the Pasteur Institute, Paris. We have also at disposal a few particulars with regard to the serum which was prepared in Bombay by Mr. Haffkine.

Details with regard to the preparation of the particular samples of Yersin's serum furnished to us by the Pasteur Institute, Paris. 26,210.

The horses which furnished the particular sera which were placed at our disposal were, as we were informed by M. Roux, of the Pasteur Institute, Paris, subjected in the first instance to hypodermic inoculations of dead plague cultures. Following upon these hypodermic inoculations, intravenous inoculations of dead plague cultures were employed. Finally, intravenous inoculations of living plague cultures were resorted to. The sera were, with a view to ensuring their perfect sterility, heated to a temperature of 60° C. before they were sent out.

Criticisms relating to the method of preparation.

If we may assume that the blood was not drawn off from the inoculated horses until these had completely recovered from the effects of their inoculations, the only point which would seem to invite comment in connexion with the procedure which is adopted is the heating of the serum prior to sending it out. The question may well suggest itself as to whether the advantages, from the point of view of securing the asepticity of the serum which result from the heating are not counterbalanced by the disadvantages associated with the destruction of the non-specific anti-bacterial substances. It might, however, be argued that, inasmuch as the non-specific anti-bacterial substances in question would probably disappear spontaneously from the serum, the heating would not make any difference in the therapeutic efficacy of the serum.

Preparation of the serum employed by Mr. Haffkine. 131-3.

500. Only very meagre details were furnished to us by Mr. Haffkine with regard to the preparation of the serum which he obtained by the injection of plague cultures into animals. We learned that the serum was furnished by horses, goats, and sheep, that "it was taken from animals at different stages of their being treated with increased quantities of plague microbes," that the treatment was in some cases continued for as long as 12 months, and that in some cases as much as 1,600 c.c. of culture was employed for the last injection.

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Method of preparation of Lustig's serum.

501. Passing to the consideration of the preparation of Lustig's serum, detailed information is afforded in a note of Professors Lustig and Galeotti published as Appendix VI. of our Proceedings and in the evidence given to us by Dr. Galeotti on the two occasions when he appeared before us. The serum is obtained from horses which have been subjected to repeated inoculations of a substance which is derived from the dead bodies of plague bacteria. The derivative substance in question is obtained in the following way. Mass cultures of plague are made on large surfaces of agar. After these have been grown for a variable period (three days or less) the plague bacteria are scraped off from the surface of the agar. This done, they are—following a method previously employed by Buchner in connexion with other bacteria—treated with a 1 per cent. solution of caustic potash. Under the influence of this re-agent, the bacterial bodies are disintegrated. When solution has been effected, the fluid in which the bacterial substances are dissolved is rendered slightly acid by the addition of hydrochloric or acetic acid. As a result of this addition, a precipitate is formed in the fluid. The precipitate in question, which apparently possesses the characters of a nucleo-albumen, is collected on a filter, and is then dried and weighed. Finally, after it has been re-dissolved in a weak solution of carbonate of soda, it is introduced either hypodermically or intravenously into the system of the horses which are to furnish the serum. The blood is withdrawn from these horses after a certain interval has elapsed from the date of inoculation.

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* It is perhaps hardly necessary to point out that this method of preparation, constituting as it does merely an application to the special case of plague of a procedure already previously largely employed in the case of bacterial diseases, is one that presents no features of novelty. In like manner it will not be necessary to insist on the fact that sera have been prepared by the method by bacteriologists all over the world and not exclusively by M. Yersin.

Criticisms relating to the specificity of the substances obtained by the above method of preparation.

The first question which suggests itself for consideration in connexion with the substance obtained by the method described above, is the question as to whether it is a specific derivative of the plague bacillus. We may note the following points.

There is nothing in the nucleo-albuminous character of the substance obtained by Lustig to warrant the belief that this substance is specific to the plague bacillus. It is true that nucleo-albuminous substances have not been obtained, and possibly are not obtainable, from all species of bacterial cells, but, on the other hand, they can—as already indicated above—be obtained, by treatment with caustic soda and precipitation with dilute hydrochloric acid, from many forms of micro-organisms, bacteria as well as yeasts.

Consideration of the little that is known of bacterial poisons suggests that it is hardly likely that substances which are specific to the plague or any other bacillus would resist the disintegrating action of the strong caustic soda which comes into operation in Lustig's process.

Again, it may be urged against the specificity of the nucleo-albuminous substance employed by Lustig that the intravascular coagulation which has been observed to supervene upon the inoculation of this substance, both in the case of mice (intraperitoneal injection) and in the case of horses (intravascular injection), notoriously comes under observation also in connexion with the injection of nucleo-albumen derived from the cells of the animal organism and also, as shown by one of us (Wright), in connexion with the nucleo-albumen derived from yeast cells.

British Medical Journal, September 16, 1891.

It might, however, seem that the question might be decided by a comparison of the toxicity assigned by Lustig to his plague nucleo-albumen with the toxicity of the nucleo-albumen which is obtained from other sources. This, however, does not help us. For Lustig's statement that the minimum lethal dose of his plague nucleo-albumen varies, according to the method of proportion adopted, between 5·28 and 8·35 milligrammes per 100 grammes of body weight of "mice, rats, and rabbits," is a statement which does not take any cognisance (*a*) of the difference of susceptibility in the various classes of animals; (*b*) of the different methods in which poison may be introduced into the body; or (*c*) of the difference between the dose of nucleo-albumen which produces death by intravascular coagulation, and the dose which produces death apart from intravascular coagulation. The importance which attaches to this last point emerges when we consider that any ordinary nucleo-albumen would, in doses much smaller than those particularised above, if intravascularly injected into a rabbit, ordinarily produce death by intravascular coagulation.

I. 347.

Hardly more conclusive as to the specificity of the nucleo-albumen obtained by Lustig is the experimental evidence brought forward to show that immunity against plague can be established by the inoculation of this substance. It is true that a certain amount of protection against plague would appear to be afforded by the injection of Lustig's plague nucleo-albumen. But this would appear to be inconclusive as to the specificity of the material employed, firstly, because, in the case of most of Lustig's experiments, both the prophylactic and the test inoculations were made into the peritoneum, and it has been shown that a short-lived non-specific immunity can readily be produced by intraperitoneal injections of the most varied substances, and secondly, because, as Wooldridge showed,—and his conclusions have been confirmed,—a certain amount of protection can be conferred upon animals by the inoculation of nucleo-albumens derived from animal cells.

Proceedings of the Royal Society 1887.
British Medical Journal, September 19, 1891.

In view of all the above considerations, we are of opinion that as yet there has been no conclusive evidence afforded that the plague nucleo-albumen which is employed by Lustig for the inoculation of his horses, is a specific derivative of the plague bacillus.

III. EXPERIMENTAL INVESTIGATIONS RELATING TO THE PROPERTIES OF ANTI-PLAGUE SERA EMPLOYED IN INDIA.

Results of laboratory examination of anti-plague serum.
134–5.

502. Excluding from consideration the serum employed by the Russian Plague Commission, regarding which we have no information, and the serum prepared and employed by Mr. Haffkine, of which we were told only that good results were obtained upon animals with certain of the sera, the only samples of anti-plague sera whose properties have been experimentally investigated in the laboratory are two samples of Yersin's serum from the Pasteur Institute, Paris, examined by the

German Plague Commission, two further samples of that serum examined by Captain Mason, R.A.M.C., in Cutch, and two samples of Yersin's and of Lustig's serum respectively placed at our disposal by the authorities of the Pasteur Institute in Paris and by Dr. Galeotti. We may conveniently dispose, first, of the examinations made by the German Plague Commission and by Captain Mason, R.A.M.C.

Examination of Yersin's serum by the German Plague Commission.

Report of German Plague Commission, pp. 325-331.

503. The first experiments undertaken by the German Plague Commission were conducted with a serum which they characterise as "the older," to distinguish it from "the newer" sample which they subsequently examined. With a view to securing that the serum should be administered under the most favourable conditions, relatively large quantities—8·5 to 10 c.c.—were administered to monkeys 24 hours before they were inoculated with plague. Three monkeys were thus treated with "the older" serum, and two out of the three died of plague. Seven monkeys were treated on similar lines with "the newer" serum; of these only two died. The deaths occurred in the case of monkeys which had received only 1 c.c. of the serum; the surviving monkeys received respectively 10, 5, 5, 3, and 3 c.c. In addition to the brown monkeys treated in the above series of experiments, two of the less resistant species of grey monkeys were treated each with 10 c.c. of serum. Both these succumbed when they were 24 hours later inoculated with 1 c.c. of a broth culture of plague. Lastly, in two series of experiments, these being conducted again on brown monkeys, the therapeutic efficacy of the serum was tested by administering it to the monkeys, after a previous inoculation with plague. Of the 11 monkeys which were treated thus, in each case with 10 c.c. of "the newer" serum, only two died, these being monkeys which had not received the serum injection until 48 hours after they had been infected with plague: of the survivors three had received the serum injection immediately after they had been infected, two received it six hours afterwards, two received it 12 hours afterwards, and two 24 hours afterwards.

Captain Mason's experimental investigation of samples of Yersin's serum.

504. The serum tested by Captain Mason, R.A.M.C., was derived from the Pasteur Institute at Paris, and was furnished in part by Horse No. 31, and apparently in part by Horse No. 88. Of six mice experimented on with quantities varying from $\frac{1}{50}$ to $\frac{1}{3}$ c.c. of the serum of Horse No. 31, three survived a subsequent inoculation with plague, while the life of the three others was prolonged as compared with the controls: these last, three in number, all succumbed. In the case of the serum which was, it appears, derived from Horse No. 88, one mouse, which received $\frac{1}{4}$ c.c. of the serum, recovered, while a control mouse died; further, of two rats which received in each case 2 c.c. of the serum at different periods after inoculation with plague virus, one, which received the serum 24 hours after inoculation with plague, survived, while the other, which received the serum 36 hours after inoculation with plague, succumbed, though its life was prolonged as compared with the control. Lastly, a monkey which received 2 c.c. of the serum 24 hours, and 20 c.c. 49 hours, after inoculation with plague survived, while a control monkey died. These results show that the serum which was tested by Captain Mason, and was used by him in Cutch, possessed the power of favourably influencing the course of plague in animals.

27,065-116.
II. 479.

Details of samples of serum examined by us.

505. We ourselves examined in all four samples of anti-plague sera. Two of these were samples of Yersin's serum, prepared at the Pasteur Institute in Paris, and placed at our disposal in a most generous manner by the authorities of the Institute; the two remaining samples of serum were samples of Lustig's serum furnished by Dr. Galeotti, who was working in Bombay under the instructions of Professor Lustig and under the auspices of the Municipality. These last samples, representing some hundreds of doses, were derived from two horses treated in Bombay, denoted respectively Horse No. 1 and Horse No. 3. The details of the inoculations and the bleedings to which these horses were subjected were very kindly supplied to us by Dr. Galeotti, as follows :— 26,210, 26,213.

The horses "received the following inoculations of nucleo proteid which was prepared by Professor Lustig's process from cultures of plague bacilli :—

Horse No. 1.

Nov. 17, 1898.	Plague-nucleo-albumen	0·18	grammes.
Nov. 28, „	„ „	0·57	„
Dec. 12, „	„ „	1·38	„
Dec. 29, „	„ „	3·97	„
Jan. 21, 1899.	„ „	1·23	„
Feb. 15, „	Bled 2,000 c.c.		
Feb. 17, „	„ 3,500 c.c.		

Horse No. 3.

Nov. 23, 1898.	0·11	grammes.
Nov. 17, „	0·92	„
Dec. 9, ..	2·85	„
Jan. 2,	1·53	„
[illegible]	59	„

00 c.c. blood extracted. The serum

[illegible]

In addition to being supplied with details as to the inoculation of these horses, two of us (Dr. Wright and Dr. Ruffer) had an opportunity, on three different occasions, of inspecting the horses—some six in number—which were under treatment by Dr. Galeotti. On each of these occasions we found the horses—we would except from this description Horse No. 1—in a condition of extreme marasmus complicated by suppuration, in absolute contrast to that condition of bodily health which is characteristic of horses who have responded to an injection of snake venom, tetanus, and diphtheria, toxins with the production of a corresponding anti-toxin. This was by itself sufficient to rebut the idea that the horses could have neutralised the poisons with which they had been injected.

Application of different methods of testing sera to special case of anti plague sera.

506. Before setting forth our own experiments on the samples of Yersin's and Lustig's anti plague sera which were tested, it will be convenient to reconsider, from the special point of view of their application to plague, the different tests which, as we have shown above, are useful in estimating the value of sera.

Para. 490 of this Report.

It has been explained above that the presence or absence of anti-toxic substances in the serum can be ascertained with certainty only when we are in a position to administer to an animal a multiple, and preferably a large multiple, of the minimum lethal dose of the corresponding poison.

Para. 425 of this Report.

Further, facts stated elsewhere in this Report show that it has not hitherto been possible to obtain the toxin of plague in a sufficiently concentrated form to allow of even small multiples of the minimum lethal dose being administered to a test animal. It is, therefore, at present, all but impossible to determine the question as to whether a particular anti-plague serum possesses any anti-toxic properties with respect to the soluble toxins of plague.

Similar difficulties, we may note, stand in the way of determining whether an anti-plague serum is, or is not, capable of neutralising poisons which are contained in the bacterial bodies; and to these difficulties are superadded other difficulties associated with the circumstance that these bacterial poisons would have to be administered in particulate form, instead of, as we saw above was essential for the avoidance of fallacies, in solution.

Experimental investigation must therefore, in the case of anti-plague sera, for the present confine itself to ascertaining whether a serum does or does not contain specific anti-bacterial substances. To the determination of this point we directed our investigations.

Results of tests applied by us with a view to ascertaining whether anti-bacterial substances were contained in the sera furnished to us.

Section III (*f*) of Chapter III. of this Report,

507. Our results may be very briefly recorded. In the case of the samples, both of Yersin's serum and of Lustig's serum, which were examined by us, we were quite unable to detect anything in the nature of agglutination or morphological alteration in the plague bacteria which were brought in contact with the diluted or undiluted serum. These observations, however, are not conclusive as to the absence of agglutinins, for, as explained elsewhere, the presence of agglutination can hardly be demonstrated with cultures such as those we were using, in which the plague bacteria are already *ab initio* agglomerated together.

Further, we were unable to satisfy ourselves by cultivation methods of the presence of any anti-bacterial substances in the serum. Plague bacteria were cultivated on Yersin's and Lustig's serum and on mixtures of those sera and ordinary nutrient broth; and these cultures were, so far as could be judged, no less luxuriant than those which were made upon normal horse serum and nutrient broth respectively.

Further, we added the serum in different proportions to fresh cultivations of plague bacteria, and we inoculated these mixtures into the peritoneal cavities of normal guinea-pigs, with a view to determining whether the serum would, in presence of the non-specific anti-bacterial substances which are contained in the normal peritoneal fluid, exert a spherulating or bacteriolytic effect. Here, again, our results were purely negative. We saw nothing which reminded us even in the remotest degree of the striking results which were obtained when cholera bacteria were introduced into the peritone[illegible]vity in association with the serum which contains the corresponding specific a[illegible]ances.

disease, in animals which received, simultaneously with an inoculation of serum, an inoculation of living plague bacteria.

508. Three series of experiments were performed by us with a view to obtaining the information in question. The results of these experiments are incorporated in the following tables brought upon our record in the evidence of Lieut. Douglas, I.M.S.

Details of our experiments to determine the therapeutic effect of Yersin's and Lustig's serum on animals.

TABLE A.—EXPERIMENTS made to TEST the PROTECTIVE POWER of YERSIN'S and LUSTIG'S ANTI-PLAGUE SERA.

26,210.

Number of Guinea-pig.	Amount of Plague Culture injected.	Amount and Kind of Serum which was injected.	Date on which foregoing Inoculations were made.	Result.	Remarks.
Number 1 (control) -	$\frac{1}{10}$th agar tube	Nil.	18.2.99	Died 22.2.99	
„ 2 (control) -	„	„	„	„ „	
„ 3 - -	„	$\frac{1}{4}$ c.c. Yersin's serum (Horse 21).	„	„ 23.2.99	
„ 4 - -	„	$\frac{1}{2}$ c.c. Yersin's serum (Horse 21).	„	„ 21.2.99	
„ 5 - -	„	1 c.c. Yersin's serum (Horse 21).	„	„ 1.3.99	Much local re-action, *vide infra Note* 1.
„ 6 - -	„	2 c.c. Yersin's serum (Horse 21).	„	„ 2.3.99	Much local re-action, *vide infra Note* 2.
„ 7 - -	„	$\frac{1}{4}$ c.c. Lustig's serum (Horse No. 3).	„	„ 22.2.99	
„ 8 - -	„	$\frac{1}{2}$ c.c. Lustig's serum (Horse No. 3).	„	„ 25.2.99	
„ 9 - -	„	1 c.c. Lustig's serum (Horse No. 3).	„	„ 22.2.99	
„ 10 - -	„	2 c.c. Lustig's serum (Horse No. 3).	„	„ 20.2.99	

In each case the serum and plague culture were injected within a few minutes of each other into opposite sides of the body.
In each case the presence of plague bacilli in the body was verified after the death of the animal.

NOTE 1.—Particulars of *post-mortem* examination of Guinea-pig No. 5. Abscess at seat of inoculation on left side of abdomen, bubo in left axilla. Pleural effusion on left side. Nodules in left lung. In all of these situations plague bacilli were detected on microscopic examination. No generalised infection. No plague bacilli were detected either microscopically or by cultivation in spleen, liver, or blood.

NOTE 2.—Particulars of *post-mortem* examination of Guinea-pig No. 6. Abscess at seat of inoculation on left side of abdomen. Suppurating buboes in both axillæ and both groins. Effusions in both pleural cavities. Lungs filled with hard greyish-yellow nodules. Plague bacilli were found scattered in small clumps through these nodules. Bacilli were recovered by cultivation from the suppurating buboes. Only a single colony was obtained in the cultivation made from the spleen.

TABLE B.—Further EXPERIMENTS made to TEST the PROTECTIVE POWER of YERSIN'S and LUSTIG'S ANTI-PLAGUE SERA.

26,213.

Number of Guinea-pig.	Amount of Plague Culture injected.	Amount and Kind of Serum which was injected.	Date on which foregoing Inoculations were made.	Result.	Remarks.
Number 1 (control) -	$\frac{1}{10}$th agar tube	Nil.	27.2.99	Died 4.3.99	
„ 2 -	„	$\frac{1}{4}$ c.c. Yersin's serum, (Horse No. 31).	„	„ 5.3.99	Marked local re-action.
„ 3 - -	„	$\frac{1}{2}$ c.c. Yersin's serum (Horse No. 31).	„	„ 6.3.99	do.
„ 4 - -	„	1 c.c. Yersin's serum (Horse No. 31).	„	„ 29.2.99	No cause of death detected, no plague bacilli were detected either microscopically or by cultivation.
„ - -	„	2 c.c. Yersin's serum (Horse No. 31).	„	„ 8.3.99	Marked local re-action, a few plague bacilli in spleen.
„ 6 - -	„	$\frac{1}{2}$ c.c. Lustig's serum (Horse No. 1).	„	„ 3.3.99	
„ 7 - -	„	1 c.c. Lustig's serum (Horse No. 1).	„	„ 3.3.99	
„ 8 - -	„	2 c.c. Lustig's serum (Horse No. 1).	„	„ 3.3.99	
„ 9 - -	„	4 c.c. Lustig's serum (Horse No. 1).	„	„ 3.3.99	

The method of experimentation was the same as in the former series of experiments.

Plague bacilli were detected after death in all the guinea-pigs with the exception of guinea-pig No 4.

TABLE C.—EXPERIMENTS made to DETERMINE the PROTECTIVE POWER of various ANTI-PLAGUE SERA and of various COMBINATIONS of ANTI-PLAGUE SERA.

26,280.

Number of Guinea-pig.	Nature and Quantity of the therapeutic Serum which was injected.	Dose of Plague Bacilli which was injected.	Date on which the foregoing Injections were made.	Result.	Remarks.
No. 1 (control) -	Nil - - - -	$\frac{1}{12}$ agar tube	14.3.99	Died 18.3.99	
„ 2 (control) -	Nil - .	„	„	„ 19.3.99	
„ 3 - -	2 c.c. Yersin's serum (horse 21)	„	„	„ 23.3.99	Much local reaction.
„ 4 - -	2 c.c. Lustig's serum . -	„	„	„ 17.3.99	
, 5 - -	2 c.c. serum from immunised rabbits.	„	„	„ 19.3.99	
„ 6 - -	1 c.c. Yersin's serum - - 1 c.c. Lustig's serum - -	„	„	„ 21.3.99	Much local reaction.
„ 7 - -	1 c.c. Yersin's serum - - 1 c.c. immunised rabbits' serum	„	„	„ 23.3.99	„ „
„ 8 - -	1 c.c. Lustig's serum - - 1 c.c. immunised rabbits' serum	„	„	„ 17.3.99	
„ 9 - -	0·5 c.c. Yersin's serum - 0·5 c.c. Lustig's serum - - 0·5 c.c. immunised rabbits' serum	„	„	„ 19.3.99	
„ 10 - -	1 c.c. immunised rabbits' serum	„	„	„ 22.3.99	Much local reaction.
„ 11 - -	0·5 c.c. immunised rabbits' serum.	„	„	„ 17.3.99	

In each case the serum and plague bacilli were injected into opposite sides of the body. The serum was in each case injected a few minutes before the plague bacilli. In every case plague bacilli were found after death in pure culture in the internal organs.

Each of the guinea-pigs which were employed for this experiment weighed approximately 350 grammes.

Results of our experiments on animals with Yersin's serum.

509. It will be seen by reference to the above tables that the administration of Yersin's serum did, when administered to guinea-pigs, exert a well-marked effect in the direction of protection. It is true that the injection of as much as 2 c.c. did not in any case suffice to ward off a fatal issue from the animals which were inoculated with plague; but, in practically every case, the administration of serum deferred the time of death, and in practically every case it held septicæmia in check, and it operated in the direction of limiting and localising the plague invasion. The protective effects which were observed in these experiments appear, so far as we are able to judge from information which was gathered by one of us in the course of a conversation with M. Roux, to have been much less marked than those which were observed in a series of experiments which were instituted at the Pasteur Institute, Paris, with the (presumably freshly drawn) sera of the same horses from which the sera supplied to us were derived. If this difference in the result is not imputable to the larger test dose or superior virulence of the cultures which were employed by us, it may conceivably have been due to the absence of the less stable non-specific anti-bacterial substances in the sera employed by us.

Results of our experiments on animals with Lustig's serum.

510. The results of our experiments with Lustig's serum may be briefly summarised as follows:—In the first series of experiments, in which four guinea-pigs—treated respectively with $\frac{1}{4}$, $\frac{1}{2}$, 1, and 2 c.c. of the serum—and two control animals were inoculated with exactly the same quantity of plague culture, the first to succumb was the animal which had received the largest dose of serum. This animal succumbed on the second day. Two days after this the controls succumbed, and along with them the serum animals which had received respectively a $\frac{1}{4}$ and 1 c.c. Only one serum animal survived longer than the control animals. This animal, which had received $\frac{1}{2}$ c.c. of the serum, survived till the seventh day. The serum which was employed in these experiments was the serum of Horse No. 3. The series of experiments with the serum of Horse No. 1 yielded no better results. In this series of experiments four guinea-pigs received respectively $\frac{1}{2}$, 1, 2, and 4 c.c. of Lustig's serum. All these animals succumbed 24 hours before the control guinea-pig. Precisely similar results were obtained in the further series of experiments shown in the last table. Here the administration of Lustig's serum appeared in every case to accelerate death. 26,215. Finally, a similar result was obtained in an unfinished experiment on rats, the results of which (so far as they were available at the date of our departure from India) are placed on record in the evidence of Lieut. Douglas, I.M.S. Here again two of the animals which received Lustig's serum died before the first control—the rat which received the largest dose (2 c.c.) dying exactly twice as quickly as this control.

It will thus be seen that in three series of experiments with guinea-pigs, and in one (unfinished) series of experiments with rats, the introduction of Lustig's serum into the plague-infected organism hastened death. In particular the animals which received the larger doses of serum showed much less power of resisting the plague infection than the control guinea-pigs.

Results of experiments on animals with Lustig's serum by Dr. Galeotti. 26,011.

511. In view of the disastrous nature of these results, we availed ourselves of the opportunity of Dr. Galeotti's second appearance before us, to inquire from him as to whether he himself had tested this serum on animals. Dr. Galeotti very kindly furnished us with the results of the experiments which he had instituted with the particular sera in question. The details of these experiments will be found incorporated in Dr. Galeotti's evidence. It appears, from the statements which are there furnished, that of three rats which were inoculated by piercing the tail with an infected needle, and which were afterwards treated with the serum from Horse No. 3, two survived, while a control rat, inoculated with the same quantity of plague, and the remaining serum rat, died. Again of three monkeys inoculated with 2 c.c. of plague culture, two, who were treated with the serum from Horse 3, survived, while the untreated control monkey died. Again in the case of the serum derived from Horse No. 1, one rat which was inoculated with a very small quantity of plague, and which was afterwards treated with serum, survived, while a control rat which was inoculated with the same quantity of plague culture died. Lastly, out of two monkeys treated with the serum last mentioned after previous inoculation with plague, one monkey survived, while the other serum monkey and a control monkey which had been injected with similar quantities of plague succumbed.

To sum up, of a total of eight animals treated by Dr. Galeotti with the sera of Horses Nos. 3 and 1 respectively, six survived, corresponding to a mortality of only 25 per cent., while of four control animals all died, corresponding to a case-mortality of 100 per cent.

Differences in results of our experiments and Dr. Galeotti's and possible explanation.

512. We are quite unable to suggest any satisfactory explanation of the striking differences between Dr. Galeotti's results and our own. Attention may, however, be drawn to the following points. With respect to the serum derived from Horse No. 3, it is to be noted that the serum which was furnished to us was drawn off on the 7th of February 1899. Our experiments with this serum were undertaken 11 days after, that is, on the 18th of February 1899. Dr. Galeotti's experiments, if, as we surmise, they were instituted with this particular serum and not with the serum drawn off from the same horse on the 5th of February, were, on the contrary, undertaken on the very day on which the serum was drawn off. Similarly in the case of the serum from Horse No. 1. The serum furnished to us was drawn off on 17th of February 1899. Our experiments with this serum were undertaken on the 27th of February. Dr. Galeotti's experiments with the serum were undertaken a week previously, on the 20th of February. It will be seen that our experiments were conducted with sera which had been standing for some 10 days, whereas those of Dr. Galeotti were conducted with the freshly drawn sera. In view of this, it is possible that the discordant results obtained may be explicable (we would note here that the same explanation has been put forward by Dr. Cobbett to account for the discordant results which have been obtained by different observers with one and the same variety of anti-strepto-coccus serum examined at different times) by the assumption that the sera in question contained unneutralised poisons which were in the case of the earlier experiments masked by the presence of non-specific anti-bacterial substances. In accordance with this suggestion, the earlier and more favourable results would be explained as the result of the incorporation of the unstable anti-bacterial substances present in fresh sera, while the unfavourable results obtained in the later experiments would be explained as the result of the incorporation of an unneutralised residuum of the bacterial poison employed for the injection of the horses.

"Lancet," 9th April 1898.

Whatever view we take of the very favourable results obtained by Dr. Galeotti in his animal experiments, it seems to us clear that the evil effects which were observed to follow in our own experiments with Lustig's serum were—as in the case of the "anti-venomous," "anti-staphylococcus," and "anti-tuberculin," and "anti-enteriditis (Klein)," sera referred to above—in all probability due to the presence of unneutralised poisons in the serum.

Para. 487 of this Report.]

Experiments made to determine whether toxic substances were contained in the sera furnished to us.

513. We instituted two series of experiments with a view to determining whether the serum furnished to us contained toxic substances in quantity sufficient to produce a fatal result in normal guinea-pigs. The results of the experiments are set forth in the following tables.

TABLE A.—COMPARISON of the TOXICITY of LUSTIG'S SERUM with the TOXICITY of NORMAL HORSE SERUM.

26,277.

Number of Guinea-pig.	Weight of Guinea-pig.	Amount and Kind of Serum which was injected.	Relation of foregoing Amount to Body Weight of Animal.	Result.
Number 1 - -	230 Grammes	Lustig's serum 11·5 c.c.	5 per cent.	No toxic symptoms observed.
„ 2 - -	220 „	Normal horse serum 11 c.c.	5 per cent.	Do.
„ 3 - -	260 „	Lustig's serum 19·5 c.c.	7·5 per cent.	Do.
„ 4 -	260 „	Normal horse serum 19·5 c.c.	7·5 per cent.	Do.

TABLE B.—RELATIVE TOXICITY of NORMAL HORSE SERUM, of YERSIN'S ANTI-PLAGUE SERUM, and of LUSTIG'S ANTI-PLAGUE SERUM.

26,433.

Number of Guinea-pig.	Amount and Kind of Serum injected.	Result.
Number 1 - -	Normal horse serum, 20 c.c. - -	Survived.
„ 2 - -	Normal horse serum, 30 c.c. -	do.
„ 3 - -	Yersin's anti-plague serum, 20 c.c.	do.
„ 4 -	Yersin's anti-plague serum, 30 c.c.	do.
„ 5 - -	Lustig's anti-plague serum, 20 c.c.	do.
„ 6 - -	Lustig's anti-plague serum, 30 c.c.	do.

Nothing in the general condition of these animals suggested that there was any difference in toxicity between these various sera.

It will be seen that in neither series of experiments was any evidence obtained of the presence of unneutralised poisons in Lustig's serum. Normal animals injected with as much as 30 c.c. (one-tenth of their body weight) of the serum remained to all appearance unaffected. This, however, is not inconsistent with the assumption that the serum may have contained small quantities of unneutralised plague poisons, such as would make themselves felt only when superadded to similar poisons elaborated in the organism of a plague-infected animal or man. Phenomena quite analogous to these have been observed by one of us (the President) in connexion with anti-venomous serum, and also by Ehrlich in connexion with milk drawn off from a goat which had a few days previously received an injection of tetanus toxin. Perhaps, however, the acceleration of death obtained in the animals treated with Lustig's serum would be most simply accounted for by the assumption that the serum contained anti-bactericidal substances similar to those recently described by one of us (Wright) in connexion with an anti-typhoid serum examined by him. It would seem possible that Lustig's serum may have exerted an anti-bactericidal effect of this kind upon the guinea-pigs experimented upon.

Zeitschrift für Hygiene, 1893.

"Lancet," 1st Dec. 1900 and 2nd March 1901.

Inferences as to propriety of applying to the treatment of plague in men the samples of Yersin's and Lustig's serum examined by us.

514. In view of the fact that the results of the experiments made with the samples of Yersin's serum which were furnished to us showed that the course of plague in animals was always modified in a favourable manner by the introduction of the serum, there could obviously be no hesitation as to the propriety of determining the effects of the therapeutic administration of this serum in the case of plague patients. At the same time, seeing that the influence which was exerted on the course of plague in animals was in no case sufficient, even when large doses were employed, to ward off a fatal issue, there was obviously nothing to warrant a very sanguine expectation as to the effect which would be realised on men.

The case of the samples of Lustig's serum at our disposal was different. Here, in view of the general tenour of the results which were obtained by us in the course of the experiments mentioned above, and in view of the deplorable effect which was exercised by the inoculation of this serum into plague-infected animals, we did not consider ourselves justified in testing the effects which would be produced by the inoculation of the serum on men. We shall, therefore, so far as Lustig's serum is concerned, confine ourselves to reviewing the results which have been obtained by others by the therapeutic application of Lustig's serum in the Bombay hospitals.

IV.—DISCUSSION OF THE METHODS APPROPRIATE FOR THE STATISTICAL ESTIMATION OF THE VALUE OF ANTI-PLAGUE SERA IN THE TREATMENT OF PLAGUE.

Preliminary considerations.

515. Our study of the effects of the therapeutic administration of Yersin's and Lustig's sera may with advantage be prefaced by setting forth certain general principles which must be kept in view in the course of our consideration of these questions.

In the first place, we must keep in view that sera issued for therapeutic use must not be regarded as substances which possess any constant composition. Not only is the proportion of the anti-toxic and anti-bacterial constituents different in different samples of serum, but the serum, as we have seen, may in exceptional cases contain toxic or "anti-bactericidal" elements. This being so, it would be impossible to form a judgment on the question of the utility of an anti-plague serum, which has been prepared by a particular process, by a study which should confine itself to the determination of the value of any one particular sample of that serum. We must, consequently, with a view to arriving at a practically useful estimate of the value of a serum as a therapeutic agent, take a general survey of the results obtained with the different samples of that serum which have been brought into application.

Sera not substances of constant composition and therefore not to be judged of by effects of any particular sample only.

We propose to do this in the case of Yersin's serum and of Lustig's serum, limiting ourselves, however, to the consideration of the samples of these sera which have been employed in India. In connexion with Yersin's serum, we have included within our purview, as already indicated in an earlier part of this Chapter, the samples of serum prepared at the Pasteur Institute, Paris, at the Imperial Institute of Preventive Medicine at St. Petersburg, and, finally, by Mr. Haffkine in Bombay. In like manner, when considering the effect of the administration of Lustig's anti-plague serum, we have studied the effects, both of the samples of that serum which were prepared in Italy, and of those which were prepared at the Municipal Laboratory, Bombay, by Dr. Galeotti, Professor Lustig's representative, and, after Dr. Galeotti's return to Italy, by Dr. A. Mayr.

Present inquiry limited to consideration of sera used in India.

516. Having defined the scope of the present inquiry, we may turn our attention to certain points in connexion with the logical methods which must be followed in adjudicating upon the utility or otherwise of a particular serum. It would be unjustifiable to base a judgment merely on the fact of a favourable or, as the case may be, an unfavourable impression being left on the mind of the clinical observer who is employing a particular serum. A judgment must in all cases be based chiefly upon a consideration of the statistical results obtained in a series of plague cases treated with the serum as compared with the results obtained in a series of cases to which the serum has not been administered.

Value of serum must be determined by comparison of statistical results in treated and untreated or control cases.

517. The statistical method adopted by us in setting forth the results obtained by the serum treatment is similar to that already employed in dealing with the results of Haffkine's anti-plague inoculation; in other words, we have set forth the case mortality in patients treated with serum and those not so treated, and the difference between these two. This method, from the point of view of the objective setting forth of the facts, seems to us to present advantages over all other methods. In particular, it seems to present advantages over the method of exhibiting the results in the form of a ratio, with 100 as a basis, between the deaths which actually occurred in the control group and the deaths which were averted in the serum group. This last method is, as it seems to us, liable to convey a false estimate of the actual saving of life achieved by a therapeutic, or, as we have already pointed out, a prophylactic agent. It may, indeed, be urged against the method adopted by us, that it is inconvenient, in so far as it does not show at a glance the degree in which the particular serum employed approaches the ideal standard of a perfectly efficacious serum. Inasmuch, however, as this can be readily ascertained by a calculation from the data supplied in our tables, the inconvenience referred to is, we think, entirely outweighed by the advantages of the method we have adopted.

The form in which statistical results are set forth. Sects. IV and V. in Chap. IV. of this Report.

Para. 454 of this Report.

518. Manifestly the soundness of comparisons between plague cases treated and not treated with serum will hinge entirely upon appropriate means having been taken to secure the selection of really comparable control cases.

Principles on which serum cases and controls should be selected.

It is, in the first place, necessary, in order to secure a just comparison that the controls and the serum cases shall have been, so far as possible, comparable from the point of view of their powers of resistance, and that they shall all have been treated in similar surroundings and, except as regards the administration or non-administration of serum, under similar conditions.

This, as consideration will show, will generally involve their having all been admitted into the same hospital; for in India, where special race and caste hospitals have been established, the patients admitted into different hospitals may, as we have already seen, possess very different powers of resistance. Again, the conditions in the

Serum cases and controls to be treated in same hospital.

Para. 300 of this Report.

different hospitals may vary, especially in the matter of the exhibition of stimulants, in the arrangements for feeding the patients, and in the adoption of European or Native methods of treatment.

Serum cases and controls to come under treatment at same period of the epidemic. Chap. III., section IX. (c) of this Report.

Equally necessary is it, in view of the facts which have been considered in discussing the variation in the fatality of plague in the different phases of an epidemic, to insist that the patients who serve as control cases shall be patients admitted to hospital in the same phase of the local outbreak as the serum cases.

Necessity for avoiding all selection of serum and control cases which involve possibility of results being influenced by the personal factor of the clinician. 19,041.

The next consideration of importance relates to the manner in which the serum and control cases are chosen from among the patients. In many cases a system of selection has been adopted, by which the clinician has selected patients for serum treatment from among the patients admitted to hospital with a view to applying the treatment only to those whose cases seemed to present certain elements for hope. In some cases, as will be seen, the results obtained in the case of these selected patients have been compared with the results obtained by ordinary treatment upon the residuum of plague cases. As an indication of the extreme to which this process of selection of patients for serum treatment has been carried, we may refer to the evidence of a witness who told us that he had known a series of three cases of plague to recover in the Hindu Fever Hospital at Bombay, after they had been excluded from serum treatment on the ground that they were already moribund. While we are far from suggesting that the process of selection of suitable cases for serum treatment has often been carried to anything like this length, it will be obvious that no logically cogent judgment can be arrived at in any case where the results obtained on a body of selected serum cases is compared with the results obtained on a body of controls consisting of residuum cases. And this will hold true, even when it is claimed that "moribund patients" have been excluded from the serum and the control group of cases alike. For it is obvious that the clinician may, without conscious bias, be making use of different standards in judging of the hopelessness of the cases, according as these are to be excluded from the serum group or from the control group. Even if this were not so, the complete exclusion of the personal factor in the selection of the serum and control cases respectively is eminently desirable from the point of view of allowing the statistics of all the various observers to be summarised in a single expression.

Exact conformity between individuals in serum and control groups need not be exacted in a sufficiently long series of observations. 20,952.

Having seen the necessity for the exclusion of the disturbing influence introduced by the personal factor of the clinician, the next question that arises is whether it is necessary to demand that the plague cases which are compared together should conform with each other in the matter of their possessing in common certain objective clinical characters. Dr. Choksy, in particular, has urged that the controls should correspond with the serum cases "as regards age, sex, race, duration of disease, position of buboes, general condition, and the state of the circulation," inasmuch as these circumstances exert an important influence on the event. Waiving the question as to whether there is not room for divergence of clinical opinion as to the correspondence of different patients with regard to certain of the points specified, we think that the conformity in question cannot, under the circumstances under which sera are applied, be secured. Further, we think that, however essential it may be in the case of a short series of observations to exact that each individual control case should correspond in the respects referred to above with the individual serum cases, this point need not be specially attended to in the case of a sufficiently long series of observations. For, in every longer series of observations the accident of chance will, if the cases are referred to the serum and control groups respectively in accordance with any arbitrary rule, spontaneously bring about the desired conformity between the serum and the control cases.

Advantages secured by the employment of the "alternate system" of selecting serum and control cases.

519. The arbitrary rule which immediately suggests itself as appropriate under the circumstances of hospital treatment is obviously that the patients admitted to hospital should be referred in the order of their admission alternately to the serum group and to the control group. The advantages which are bound up with the adoption of this rule are manifestly the following:—firstly, the clinician being relieved from all responsibility for the selection of cases, this important disturbing personal factor can be eliminated from consideration; secondly, the patients necessarily come under observation in the same hospital and in the same phase of the epidemic.

Objections urged by Dr. Choksy to the "alternate system." Bombay Medical

Dr. Choksy, who has, as we shall see, conducted a series of observations on this which he conveniently calls the "alternate system" on a series of 968 plague patients admitted to the Arthur Road Hospital in Bombay, has, in a recent publication in which he details the results of the comparison in question, urged that serious fallacies and Physical Society, September 1900.

are involved in this method considered as a method for eliciting the value of the therapeutic administration of a serum. The objections of Dr. Choksy, affecting as they do the question of the principle of selection of controls now under discussion, may appropriately be considered here.

Objection that in practice severity of cases in both groups does not equalise even in long series.

520. Dr. Choksy contends that even in so extensive a series of observations as that undertaken by him, where he dealt with two groups, each comprising 484 patients, the severe and the light cases which fell to the serum group and the control group respectively, did not, in point of fact, counterbalance each other. He points out that while the convalescents included in his group of 484 serum cases numbered only 29, the convalescents included in his 484 control cases amounted to 38. It will be noted that this, which is a difference of 9, works out, when expressed in a percentage on the number of patients in each group, as a difference of 2 per cent. Again, in the matter of the number of moribund patients included in each group, Dr. Choksy points out that the moribund patients included within the serum group numbered 139, as contrasted with 147 moribund patients included within the control group. This difference of 8 works out as a percentage difference of a little less than 2 per cent.

This objection fails.

Dr. Choksy has, it would seem, failed to observe that these differences, which have arrested his attention, mutually counterbalance each other, and that the 9 additional convalescents who fell to the control group were compensated for by the 8 additional moribund patients who fell to this group. Thus, in the case of Dr. Choksy's series of 968 cases, a practical equality is, as was *à priori* anticipated, established between the serum group and the control group.

Objection that results in favour of serum are watered down by inclusion of moribund and convalescent cases.

521. The second objection urged by Dr. Choksy is, in our opinion, both a subtle and an important one. He points out that under the "alternate system" deaths referable to patients admitted to hospital in a moribund condition are debited to both the serum group and the control group, and further, that recoveries referable to patients admitted in a convalescent condition are in a similar manner credited to both groups, and he urges that as a result of this the fact is obscured that a much larger balance inures to the credit of the serum group than inures to the credit of the control group on account of recoveries of patients admitted to hospital "in the acute stage of the disease and in a non-moribund condition," that is, of patients who when admitted are still capable of being benefited by treatment with serum.

The gravamen of Dr. Choksy's argument will appear more clearly when the figures (taking Dr. Choksy's figures for the 968 patients to whom he refers in his publication of September 1900, mentioned above) are placed before us in the following form:—

TABLE I.

Figures as they stand in the Hospital Records, Moribund and Convalescent Patients being included in both the Serum and the Control Groups.

—	Cases.	Deaths.	Recoveries.	Case-Mortality.
Control Group - - -	484	385	99	79·5 per cent.
Serum Group - - -	484	329	155	68 per cent.
Difference in favour of the serum group - -				11·5 per cent.

If, however, the number of deaths and recoveries referable to convalescent and moribund patients respectively were subtracted from both the serum and the control groups, the figures would read as follows:—

TABLE II.

*Figures as they would stand if amended in accordance with Dr Choksy's suggestion, by subtracting from each group the Convalescent and Moribund Patients * which fall to each group.*

—	Cases.	Deaths.	Recoveries.	Case-Mortality.
Control Group - -	299	238	61	80 per cent.
Serum Group - -	316	190	126	60 per cent.
Difference in favour of the serum group - -				20 per cent.

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* The numbers of these have been given in para. 520 supra.

It will be seen that the difference between the serum cases and the control cases, which amounts, when all the patients admitted to hospital are taken into consideration, to 11·5 per cent., comes out as 20 per cent. as soon as the convalescent and moribund patients are left out of consideration.

This objection sound in principle.

We are thus brought face to face with the fact that the full measure of the benefit that may accrue from a serum cannot be ascertained unless when there have been eliminated from consideration all patients who are admitted to hospital in a condition from which recovery is impossible, and all patients admitted at a stage when there is no longer any risk of a fatal issue.

Reasons why it is impracticable and inadvisable to apply the principle of excluding moribund patients in statistical investigations.

522. It is, however, one thing to recognise that it would be desirable to eliminate these classes of patients from consideration and quite another to arrive at the opinion that it is desirable to attempt to do so. As a matter of fact, the adoption of the system of eliminating unsuitable cases would involve the introduction of important sources of error into the statistics. It would manifestly be impossible by any system of examination to eliminate on admission all moribund patients, without, at the same time, eliminating all the more serious cases; in other words the elimination of the moribund patients would inevitably lead to the testing the serum only upon the less grave cases. Again, it would not be legitimate to eliminate from the records, as patients admitted in a moribund condition, all such patients as might happen to die within twenty-four hours or any other arbitrary period after admission, for this might, in the case of patients who died after the administration of serum, result in improperly eliminating from the record a certain proportion of the unsuccessful cases. Moreover, in the conceivable case of the therapeutic administration of a serum being followed by evil effects, the fact that these evil effects had followed would be obscured.

A further point relates to the question as to whether the conclusion, which is to be arrived at by the statistical investigation of the effect of the administration of the serum, shall have reference to the effect of the serum when administered under ideally favourable conditions, or to the effect of the serum when administered under the conditions under which plague patients are actually admitted to hospital in India. It seems to us that the information which a statistical investigation like the present is designed to elicit is information with regard to the effect of the serum when administered under the actual conditions of hospital practice in India. We are influenced in arriving at this opinion by the consideration that it is not possible to secure the admission of patients into hospital at an earlier a stage than that at which they are now brought in. This being so, the elimination from the statistics of the patients who die within an arbitrary period after admission would lead to an altogether wrong estimate being formed of the benefit derivable from serum-therapathy in actual hospital practice.

We may illustrate what we have just said by considering the parallel case of the therapeutic application of anti-tetanic serum to the treatment of tetanus. In the case of this particular serum, it is quite beyond doubt that we are dealing with an agent of extraordinary therapeutic potency. There are, in point of fact, very few, if any, therapeutic agents which are, from the point of view of their potency, comparable to anti-tetanic serum. Yet when an anti-tetanic serum is administered to a patient, in whom the symptoms of tetanus have already developed, instead of being administered to him immediately after the tetanic poison has been incorporated, the results which are obtained are notoriously disappointing. Now, manifestly, from the point of view of practical life, the value of the serum must be appraised, not by the effect that it is capable of exerting in ideally favourable conditions, but by the effect which it is capable of exerting under the conditions when the patients came under treatment. It seems to us that the value of serum-therapathy in plague ought to be appraised on exactly the same principle.

For the reasons given above, we feel ourselves constrained to demur to the exclusion from consideration of patients admitted in a moribund condition unless the denotation of the term "moribund" is restricted to patients admitted in a pulseless condition, or actually in articulo mortis.

The criterion of efficacy of a serum of prime importance is the larger number of survivors among the serum as contrasted with control cases.

523. Our attention must next be directed to the question of the criteria by which the effect of a therapeutic serum is to be judged. It would, at first sight, seem that the only possible criterion of the efficacy of an anti-plague serum would be the survival of a greater number of plague patients among those treated with the serum than among the untreated control cases. Reflection, however, shows that the serum and control cases might be compared also in other respects.

Subsidiary criteria are :—
Postponement of death or shorter convalescence;

In the first place, a comparison might be instituted between the serum and the control cases, with a view to determining whether death was postponed, and whether recovery was hastened, in the serum cases as compared with the control cases.

Amelioration of symptoms;

Another means by which the efficacy of a serum could be judged, would be by comparing serum cases with control cases, with a view to determining whether any particular symptom or group of symptoms was alleviated by the administration of the serum.

Comparison of case-mortality of patients treated early and late with controls in similar stages of the disease;

Again, important indications with regard to the efficacy of a serum can be gleaned by comparing the case-mortality of patients admitted and treated with the serum in the earlier stages of their illness with the case-mortality of untreated patients admitted at the same stages of their illness. Even if the aggregate of serum cases did not show any greatly reduced death rate in comparison with the untreated cases, it would be justifiable to expect that patients admitted to hospital early in their attack and immediately treated with serum would, if the serum was effective, compare in a distinctly favourable manner from the point of view of their death rate with control cases admitted in the same stage of the attack, and would, at any rate, compare more favourably with their controls than would cases treated with serum in a later stage of their illness.

Comparison of serum cases among themselves according to their treatment, early or late in the disease.

Lastly, indications might be obtained with regard to the efficacy of a serum by comparing a group of serum cases among themselves, with a view to determining whether there was any difference between the case-mortality of the patients who received the serum in the early stages of their attack, as compared with the case-mortalty of the patients who received the serum after they had reached a more advanced stage of the disease. In contradistinction to the view which recommends itself to the German Plague Commission, Captain Childe, I.M.S., Dr. Simond, and other observers, we regard indications which can be gathered from comparisons of this nature as of no great value.

III. 462(6). 27,045.

Discussion of the value of the criterion last stated.

524. In justification of this position we would suggest that the view that an effective anti-plague serum must necessarily be more effective when administered to patients admitted to hospital shortly after they have fallen sick, than when administered to patients admitted to hospital in the later stages of the disease, would appear to be based upon analogy with the different results obtained, in the case of animals which have been injected with toxins, by the early or late administration of the corresponding anti-toxic sera. We may point out certain essential points of difference between the conditions of such experiments and the conditions which we have to deal with in the case of patients suffering from plague.

In the case of a group of animals experimented upon with a view to determining the therapeutic efficacy of an anti-toxic serum, each animal receives a dose corresponding in every case to a lethal dose, or multiple of lethal dose, of the toxin in question. Death or survival of the individual animals in such a series of experiments will—given that the dose of serum contains a sufficiency of anti-toxin to neutralise the poison which has been incorporated—hinge entirely upon the introduction of the anti-toxin sufficiently soon after the incorporation of the toxin to allow of its neutralising this last before the tissues which are essential to life have been poisoned.

The conditions are entirely different in the case of plague patients admitted to hospital in the earlier or later stages of the disease respectively. The conditions are not here such that all the patients if left untreated will succumb, because it is not certain in the case of all these patients that a lethal dose of plague poisons has been or will be elaborated in their systems by the plague bacteria which have invaded them. On the contrary, the favourable or non-favourable issue will in each case hinge upon the question as to whether the bacteria succeed in or are prevented from propagating themselves in the organism up to the point at which they shall have elaborated poisons in sufficient quantity to bring about a fatal issue. In conformity with this, there will be very considerable differences between the cases of individual patients who are, from the chronological standpoint, in the same stage of the disease. Some will have been infected with smaller, others will have been infected with larger, quantities of the plague bacillus ; again, there will be some who have been infected with a more virulent, others with a less virulent, bacillus ; lastly, some will have succeeded better than others in inhibiting the growth of the plague bacilli which have effected an entrance into their organism. If, however, we take the average of patients admitted on particular days of the disease, and compare among themselves the groups admitted on successive days, we arrive at the following inferences. The patients admitted in the first day of the disease may be assumed to conform to the average, both from the point of view of the general severity of the infection and also from the point of view of resisting power. The mortality among this group of patients would thus accurately agree with the average mortality from plague at the particular period of the epidemic in which they come under observation. Passing now to the patients admitted in the second day of the disease, these patients—we may for present purposes omit from consideration the patients who are admitted in a manifestly moribund condition—represent a group of patients from among whom have been removed by death a certain number of the most severely infected and of those possessing the least resisting power. Second day patients, taking them on the average, thus represent those who have been less dangerously infected, or who possess by nature a higher resistance, than the average of patients in the first day of the disease. The same will hold true of each successive group of patients, as compared with other groups of patients admitted at an earlier stage of the disease; for from each of the successive groups a larger progressive total of less resistant or more seriously infected patients will have been eliminated by death. In other words, just as in the case of the individual plague patient the prognosis becomes more favourable with the lapse of each successive day, so the prognosis is always more favourable in the case of a group of patients admitted at a later stage of the disease as compared with a group of patients admitted at an earlier stage. Dr. Simond's experience is—though he fails to see the bearing of this on the general question of the value of the criterion now under discussion—in consonance with these considerations. Speaking of the opinion that "fresh cases," viz., cases admitted to hospital in the earlier stages of the disease, "have more chances of natural recovery," he says: "This is a great mistake, and it is only necessary to consult the statistics of the hospital to see that the greatest mortality always occurs in patients admitted in the first three days. Experience has proved to me that if the serum is injected in those admitted to hospital after the period has passed, an excellent proportion of success will be obtained, but one cannot with certainty attribute it to the treatment." II. 459.

Enough has now been said on this subject to make it plain that if a serum gives better results on patients admitted to hospital and treated when they have arrived at the later stages of the disease than on patients admitted and treated early, this will not constitute disproof of the efficacy of the serum; on the contrary, the serum may be expected to yield more satisfactory results on the residuum of patients who have arrived at the later stages of the disease whose case-mortality is naturally light, than on the plague patients admitted on the first day of the disease, whose case-mortality is naturally heavy, accurately representing as it does the actual case-mortality of plague.

Fallacies incident to criteria involving comparisons between cases treated early and late.

525. If the prognosis of cases admitted to hospital in the later stages of the disease were uniformly more favourable than that of cases admitted in the earlier stages of the disease, comparisons between early and late cases would, at any rate, always show an advantage in favour of the late cases. Other factors, however, come into consideration.

One of the most important of these is the fact that many patients are admitted to hospital in an actually moribund condition, and it would seem to depend largely on chance whether such patients would fall into the category of patients admitted to hospital on the first, second, third, fourth, fifth, or subsequent days of the disease. Since, however, death in plague takes place more often on the fourth or fifth day than on the first three days, it may be assumed that in normal circumstances the percentage of patients admitted in an actually moribund condition will be higher in the case of patients admitted on the fourth and fifth days than in the case of those admitted on the earlier days. The result of this will be that where patients admitted in a moribund condition are, equally with those whose cases present elements of hope, injected with serum, a factor will be introduced into the statistics which will operate in the direction of increasing the case-mortality of those treated later, as compared with those treated early with serum. It will be obvious that statistical proof or disproof of the superior efficacy of a serum when administered early may, when this source of error has not been specially guarded against, be quite fallacious. This fallacy will be the more serious where, as in many series of experiments, the cases treated in the later stages of the disease are relatively fewer and more severe as compared with the cases treated with serum in the early stages.

Finally—and this, regarded as a source of fallacy, probably exceeds in importance all the others which insinuate themselves into a comparison instituted between cases treated early and cases treated late with serum—it is in India very difficult to obtain accurate information with regard to the date of the onset of the attack. It is generally absolutely impossible in the case of patients admitted in a moribund condition. Further, in many cases—and this, as we shall see, is said to have occurred in every case in the Seth Vishandas Hospital, Karachi—the native statements, which, with regard to the lapse of time, are in all cases very untrustworthy, were designedly falsified with a view to concealing the fact that their cases had not been reported to the authorities.

Para. 543 of this Report.

For all the reasons we have given above, while we shall, in the course of our examination of the serum statistics, take occasion to set forth the results arrived at by comparisons of the case-mortality of patients treated with serum in an early stage of the disease with the case-mortality of patients treated with serum in the later stages of the disease, we shall not rely to any extent upon these results in forming our judgment on the efficacy or otherwise of the sera which we shall have under consideration.

V.—RESULTS OBTAINED BY THE THERAPEUTIC ADMINISTRATION OF YERSIN'S SERUM TO HUMAN PLAGUE PATIENTS.

V.(A.) *Results obtained in the Observations made by Ourselves.*

Account of our observations in Bangalore with Yersin's serum.

526. We pass now from this to consider the results obtained by the inoculation of Yersin's serum into patients suffering from plague. We may conveniently deal first with our own observations and then pass to consider those made by other observers.

The serum which was employed by us was, as has already been stated, very generously placed at our disposal by the authorities of the Pasteur Institute in Paris. After consultation we decided that the serum could be most advantageously employed in Bangalore, where a serious epidemic of plague was raging at the time of our visit in December 1898. With a view to avoiding the fallacies associated with the employment of any system of selection, we decided that the treatment should be applied without distinction to every plague patient not obviously convalescent who should be admitted to hospital. We selected the South Camp Hospital, one of the two larger Plague Hospitals which had been established in the Civil and Military Station of Bangalore, as the hospital which should furnish the patients for serum treatment. The North Camp Hospital, which received a similar class of patients, was selected to furnish the controls. In accordance with the above programme, the serum treatment of the patients admitted to the South Camp Hospital was undertaken by Lieutenant Stewart Douglas, I.M.S., who was specially attached to us for this purpose. The first case was treated with serum on the 25th of December 1898, each subsequent patient being treated soon after admission, provided that there was no doubt as to the diagnosis of plague, and provided further that the patient was not already convalescent, or absolutely in articulo mortis. The epidemic coming to an almost abrupt termination in January 1899, only three plague cases were admitted and treated with serum in the South Camp Hospital after the 12th of January. For the same reason there were no further admissions subsequent to this date into the North Camp Hospital.

Including the three patients referred to as admitted after the 12th January, 49 plague patients in all were treated with serum. Of these, 31 succumbed to the disease, giving a case-mortality corresponding to 63 per cent. The details of the cases and the particulars as to the amount of serum employed are printed in Appendix LXXIX. of our Proceedings and an abstract of the cases is subjoined below in tabular form. It will suffice here to remark that the serum was generally administered once a day, and the daily quantity administered in the first 28 cases varied between 10 and 20 c.c.; in the 21 remaining cases, 40 c.c. were administered on admission to hospital, and generally 20 c.c. on each of the subsequent days. With regard to the clinical type of plague treated, the cases were, with eight exceptions, well marked bubonic cases. In a considerable proportion of cases lung symptoms, in the form of bronchitis and œdema of the lungs, occurred during the progress of the disease, or were present when the patient was admitted.

III. 593–619.
Para. 531 of this Report.

Statistics of gross case-mortality in Bangalore Hospitals during period of serum treatment.

527. For the purpose of comparing the gross case-mortality of the South Camp Hospital with that obtaining in the corresponding period in the North Camp Hospital, we must add to the serum cases treated up to the 12th of January the number of moribund and convalescent plague patients admitted into the South Camp Hospital and the other patients admitted in whose case the diagnosis of plague was doubtful. After making the necessary additions which come under these headings, the comparison between the Hospital where the serum was employed and the Control Hospital, where presumably all the classes of patients just specified were represented, would read as follows:—

III. 620.

Hospital.	Cases.	Deaths.	Case-Mortality.
North Camp Hospital, where the patients served as controls	54	29	53·7 per cent.
South Camp Hospital, where the large majority of patients were treated with serum.	73	35	47·9 per cent.

Difference in favour of the hospital where the serum was employed - 5·8 per cent.

Conclusions from statistics of gross case-mortality.

It will be seen there was a small balance, but only a very small balance, to the advantage of the hospital where the serum treatment was applied. No conclusion as to the efficacy of the serum treatment can, however, be drawn from this fact, for a difference in three or four fatal cases admitted into the North Camp Hospital during the period in question would have sufficed to turn the scale to the advantage of this hospital. Again, in the previous history of the two hospitals the North Camp Hospital had always shown the higher case-mortality. We find that the previous record of the North Camp Hospital reads 365 cases with a case-mortality of 75 per cent., while the record of the South Camp Hospital reads 686 cases with a case-mortality of 58 per cent. There was thus in the period previous to the period under consideration a balance of nearly 17 per cent. in favour of the South Camp Hospital, as compared with a balance of only 6 per cent. during the time that the serum was employed.

III. 620.

Effect of serum treatment in Bangalore according to date of disease on which treatment was initiated.

It was not observed that any of the symptoms were markedly alleviated by the serum treatment, or that the life of patients was prolonged. The serum treatment did not give any better results in the cases where it was inaugurated early than in the cases where it was inaugurated in the later stages of the disease. Taking the patients in the order corresponding to the stage of the disease at which they had arrived when they first received the serum, and excluding two patients in whom the duration of the disease was unknown, the record of mortality runs as follows:—

Days of Disease.	1st.	2nd.	3rd.	4th.	5th.	6th.	7th.	9th.
Cases - - -	2	8	11	7	7	9	2	1
Deaths - - -	2	6	7	2	4	6	1	1
Cases-mortality - -	1 in 1	1 in 1·3	1 in 1·6	1 in 3·5	1 in 1·7	1 in 1·5	1 in 2	1 in 1

It does not appear from these results that there was any important difference in the case-mortality of patients treated on the different days; if anything, the mortality was slightly greater in those who were treated earlier with serum, except in the case of patients treated on the fourth day of the disease. The number of cases, however, is not sufficiently large to form the basis of any conclusion.

Observations carried out in the Modi Khana Hospital, Bombay.

528. In view of the dying out of the epidemic in Bangalore, the theatre of operations was transferred to Bombay, and the observations were continued on patients admitted to the Modi Khana Hospital, which was situated conveniently near the Laboratory in the Municipal Buildings which was occupied by us. It was very kindly arranged by Dr. Turkhad, Medical Officer in charge of the Hospital, that every second patient who was admitted to hospital should be placed at our disposal for the serum treatment, the intermediate patients serving as controls. The supply of serum which was still at our disposal sufficed for the treatment of 28 cases in the Modi Khana Hospital.

The actual treatment and recording of the cases was undertaken by Captain Walton and Lieutenant Stewart Douglas, I.M.S., two of us (Dr. Wright and Dr. Ruffer) watching the results. The amount of serum injected was, as a rule, 40 c.c. on admission, often with a second dose of 20 c.c. on the same day, two doses of 20 c.c. each generally being injected on each subsequent day of treatment. The details of the cases are set forth in Appendices LXXX. and LXXXI. of our Proceedings. The general results were as follows:—

26,203-7.
Effect of serum treatment in the Modi Khana Hospital on case-mortality.
III. 621-633, 634-43.

——	Cases.	Deaths.	Case-Mortality.
Control Group - - -	28	24	85 per cent.
Serum Group - - -	28	23	81 per cent.

Difference in favour of the serum group - - - 4 per cent.

It will be manifest that the advantage in favour of the serum cases was quite insignificant.

Comparability of serum cases and control cases in the Modi Khana Hospital.

The cases submitted to treatment were closely comparable to those which served as controls. All the cases were bubonic cases, no cases of primary septicæmic plague or of primary pneumonic plague having been admitted to hospital during the period of observation. The patients were all males between the ages of ten and sixty. The patients in the early and late stages of the disease were represented in approximately equal proportions in both groups. This will appear from the following table:—

——	3rd Day.	4th Day.	5th Day.	6th Day.	7th Day.	8th Day.	9th Day.	Undetermined.
Control Group - -	10	9	2	1	2	1	1	2
Serum Group - -	11	8	5	0	2	0	1	1

Effect of serum treatment in the Modi Khana Hospital according to stage of disease at which treatment was initiated.

The fact that the control cases were so closely comparable with the serum cases from the point of view of the stage of the disease at which they had arrived, affords a favourable opportunity for comparing the course of the disease in patients admitted and brought under the serum treatment in the early and late stages of the disease, with the course of the disease in the untreated patients who were admitted in the same stages of the disease. The result of this comparison is shown in the following table:—

——	3rd Day.	4th Day.	5th Day.	6th Day.	7th and later Days.
	Case-Mortality.	Case-Mortality.	Case-Mortality.	Case-Mortality.	Case-Mortality.
Control Group - -	1 in 1·1	1 in 1·3	1 in 1·2	—	1 in 3
Serum Group - -	1 in 1·1	1 in 1·3	1 in 1	1 in 1	1 in 1·3

It is clear that the serum cases admitted and treated early with serum do not show any diminished case-mortality as compared with the untreated cases admitted in the same stage. Nor, again—but we have above already pointed out that no certain inference can be drawn from such comparisons—does the comparison of the mortality of cases treated early with serum, as compared with the mortality of cases treated with serum in the later stages of the disease, show that the treatment was more efficacious in the former class of cases.

Efficacy of larger and smaller quantities of serum.

529. In connexion with the question of the comparative efficacy of larger and smaller quantities of serum, we may mention that, while the first 28 cases, which were treated at Bangalore with the smaller doses of serum, gave a case-mortality of 1 in 1·4 cases, the 21 later cases, which were treated with larger quantities of serum, gave a mortality of only 1 in 1·9. We cannot, however, infer anything from this comparison with regard to the efficacy of the larger quantities of serum, for on the one hand the

figures are quite small, and on the other hand, the epidemic, and with it the case-mortality, was rapidly declining. The cases in Bombay, being of a much severer type, cannot be compared with those in Bangalore.

Effect of serum on special symptoms in cases treated in the Bangalore and Modi Khana Hospitals.

530. We may now examine the question whether the symptoms presented by the patients were modified to any considerable extent by serum treatment, for although serum treatment might have no effect in prolonging life, it might nevertheless prove useful in alleviating suffering.

Effect on temperature in cases ending in recovery.

It is an undoubted fact that, not unfrequently, the temperature rapidly sinks soon or within three to four hours after the injection of serum ; but inspection of the series of charts prepared by Captain Walton and Lieut. Douglas shows that this fall of temperature is generally of very short duration, and that a rise of temperature sometimes follows the injection. Indeed, a series of charts of cases which recover under serum treatment does not differ in any characteristic manner from that of a series of cases that have recovered under ordinary treatment ; no characteristic difference in the course of temperature can be found between them.

Effect on temperature in cases ending fatally.

Even in severe cases ending fatally a fall of temperature may supervene upon the injection of serum. This, however, is exceptional. The fall, when it occurs, is a very transient one, and often lasts but a short time. A rise of temperature, as the following examples will show, occasionally supervenes on the injection of serum.

Appendix LXXIX., III. 593.

Case No. I., inoculated with 20 c.c. of serum on the 3rd day of the disease, at 11.30 a.m. :—

Temperature at 9.0 a.m. - - - - 103·4
Do. at 12.45 p.m. - - - 104·2
Do. at 3.0 p.m. - - - - 104·6

Appendix LXXIX., III. 595.

Case No. V., inoculated with 10 c.c. of serum, on the 2nd day of the disease, at 1.30 p.m. :—

Temperature at 1.30 p.m. - - - - 103·8
Do. at 4 p.m. - - - - 105·4

Appendix LXXIX., III. 599.

Case No. XIII., inoculated with 20 c.c. of serum, on the fifth day of the disease, 9 a.m. :—

Temperature at 9 a.m. - - - - 97·4
Do. at 11 a.m. - - - - 101
Do. at 1 p.m. - - - 105·4
Do. at 2.30 p.m. - - - 105·6
Do. at 5 p.m. - - - - 104

Appendix LXXIX., III. 612.

Case No. XXXVIII.—This, like Case V., was injected with serum within 24 hours of the onset of symptoms. At 9 a.m. in the morning, 40 c c. of serum were injected, the temperature at the time being 100·8 F. At 2.20 p m. the thermometer indicated 102·6° F. At 5 p.m. it was 102·2, and it stood at the same point the next morning. At 9 a.m. 20 c.c. of serum were injected. By 3 p.m. the thermometer had risen to 103·2, but in two hours fell suddenly to 99·4. At 10 a.m. the next day, the temperature was 100·2° F., and at 1 p.m., when 20 c.c. of serum were injected, it had risen to 103·2° F., but it fell to 99·2° F. by 5 p.m. The temperature therefore showed the oscillations often seen in cases of severe plague just as if no serum had been injected, and this although the treatment had commenced within 24 hours of the first symptoms.

Appendix LXXX., III. 626, 628.

Even enormous doses may be without influence on the temperature. Thus in Cases Nos. XI. and XV., 160 c.c. and 135 c.c. were injected in four days with no beneficial effect on the temperature.

It seems to us possible that the rise or fall of the temperature curve after the injection of the serum may stand in connexion with the time of the day at which the serum is injected. We notice that in the case of 10 patients who were injected with serum both in the morning and afternoon, the morning injection was followed by a rise of temperature within 2 to 5½ hours in seven cases, in two cases there was a fall within 2 to 5 hours, and in one case the temperature remained the same. On the other hand, after the 10 injections made after 12 noon, in seven cases the temperature fell within 2 to 2½ hours, in two it was higher, and in one case it underwent no change.

Effect of serum injection on the pulse.

The temporary effect noticed on the temperature is also noticeable on the pulse, which becomes stronger, fuller, and slower, but the effect is but transitory ; and the pulse curve of cases treated with serum shows no appreciable difference from the curve of other cases recovering on ordinary treatment. After injection of serum, although the temperature may be going down, the pulse rate often shows no alteration. This is well illustrated by Case No. IV., as the following notes will show :—

Appendix I. III. 623.

	Temperature.	Pulse.
At the time of injection of serum 40 c.c. -	103·4° F.	116
4 hours afterwards - - -	99·6° F.	120
8 " " - - -	101·2° F.	116
12 " " - - -	98·0° F.	128
16 " " - - -	100·0° F.	116
24 " " - - -	101·6° F.	108

Towards the end of the illness, when the patient recovers, the pulse resumes its normal rate, but not until some time after the temperature has returned to normal.

Effect of injection on respiration

A distinct temporary improvement in the respiration often follows the injection of serum, the respiration rate following the pulse rate very closely.

Effect of injection bubo

The serum appears to exert no effect whatever on the buboes. In some cases the bubo became smaller and markedly less painful, but in many others, in spite of repeated injections of serum, the bubo enlarged, and the tissues over it became more œdematous. Out of 20 bubonic cases that recovered, suppuration occurred in seven.

Effect of injection ung complic

Since there was not either at Bangalore or in Bombay a single case of primary plague pneumonia admitted to hospital while the serum treatment was in progress, no opportunity presented itself for studying the effect of the serum on such cases. On the other hand, no less than 27 of the patients treated with serum showed lung symptoms either on admission or during the progress of the disease. Of these 21 died, and six recovered. The lung symptoms in the six cases ending in recovery were of the slightest. The symptoms in those who died varied from a few rhonchi, over one or both lungs, and prolonged expiration to well-marked lobular or lobar pneumonia. Pneumonia was present in six cases. In three cases the symptoms of pneumonia appeared some considerable time after the serum treatment had been begun; in one case they appeared after four days; in another after two days; in the last case, the pneumonia appeared when the patient was convalescent and proved fatal in a few hours,—whether it was or was not due to an invasion of the lungs by the plague bacillus could not be ascertained.

It will be seen that the serum treatment appears to exert little or no influence on the supervention or course of the lung complications which are so commonly met with in plague.

Eff rum inje n delir nd other ous sym

In many cases the patients appeared to be rather less restless after the injection of serum, the delirium somewhat abating. Unfortunately, the improvement in the nervous symptoms is by no means constant. Many patients, in spite of repeated injections, suffered from most violent delirium and had to be tied down in bed.

Eff erum inj n conv nce and pro on of life

In the cases that recovered convalescence was slow and tedious, being no more rapid than that of other patients.

Again, life did not appear to be appreciably prolonged in the patients who succumbed after treatment with serum. In the case of 51 patients regarding whom details as to the duration of the disease are available, the date on which death supervened is shown in the following table :—

2	died on	2nd day.	5	died on	8th day.
3	"	3rd day.	3	"	10th day.
11	"	4th day.	1	"	11th day.
9	"	5th day.	1	"	12th day.
7	"	6th day.	1	"	17th day.
8	"	7th day.			

No less than 25, therefore, died before the sixth day, and the average duration of the disease was just over five days; this corresponds to what might have been expected if no serum had been injected.

of death i patients.

In six cases death seemed to be due to the supervention of pneumonia; in the other cases it seemed to be due to exhaustion and heart failure; this last sometimes set in with great rapidity. In two cases convulsions set in immediately before death.

ct of cases with 's serum dore and Khana tals.

531. We may conclude our Report on the observations made by us on Yersin's serum by setting forth in tabular form, firstly, an abstract of the cases of plague which were treated with serum; secondly, details regarding the serum injection resorted to in each case.

ABSTRACT of CASES treated with YERSIN'S SERUM, prepared at the Pasteur Institute, Paris.

Cases No. 1 *to* 49 *treated at the South Camp Hospital, Bangalore ; Cases No.* 49 *to* 77 *treated at the Modi Khana Hospital, Bombay.*

Serial No.	Reference to Detailed Notes.	Sex.	Age	Date of Disease on which Serum first injected.	Situation of Bubo.	Quantity of Serum Injected.	Date of Disease, or Period after Injection, at which Death occurred in Fatal Cases.	Remarks.
1	APP. LXXIX. I.	Male	45	3rd day	Left groin	35 c.c. in 2 doses	On the 4th day of disease	In spite of injection temperature rose for more than 3 hours. No lung complications.
2	II.	Male	25	2nd day	Right axilla	20 c.c. in 1 dose	On the 3rd day of disease, 20 hours after injection.	No respiratory symptoms.
3	III.	Female	25	3rd day	Right axilla	20 c.c. in 1 dose	On the 4th day of disease, 15 hours after injection	No lung symptoms.
4	IV.	Female	20	3rd day	Right axilla	56 c.c. in 4 doses on 4 days.	On the 6th day of disease	Developed lung symptoms, probably of pneumonic type shortly before death.
5	V.	Female	8	2nd day	Left groin	20 c.c. in 2 doses	On the 2nd day of disease, about 24 hours after first injection, and about 5 hours after last.	No respiratory symptoms.
6	VI.	Female	35	3rd day	No bubo	40 c.c. in 3 days	- - - - -	Recovered. The case was complicated by an attack of malaria. No lung symptoms.
7	VII.	Female	30	2nd day	Right groin	17 c.c. in 1 dose	On the 2nd day of disease, half an hour after injection.	No lung symptoms. Patient was pregnant.
8	VIII.	Female	13	6th day	Right inguinal and right femoral.	23 c.c. in 2 doses on day of admission.	- - - - -	Recovered. Bubo suppurated. No lung symptoms.
9	IX.	Female	12	4th day	No bubo	10 c.c. in 1 dose	- - - - -	Recovered. Not injected till day after admission to hospital. Slight lung symptoms.
10	X.	Male	40	3rd day	Submaxillary region.	17 c.c. in 1 dose	On the 3rd day of disease, about 12 hours after injection and admission.	No lung symptoms.
11	XI.	Male	48	4th day	Left inguinal region.	90 c.c. in 5 doses	- - - - -	Recovered. No suppuration. No lung symptoms.
12	XII.	Male	12	3rd day	Right axilla	45 c.c. in 3 doses	On the 8th day of the disease.	The case is peculiar, in so far that the patient was so well on the morning of 6th day that no injection was given. In the afternoon he was so much worse that an injection was given. No lung symptoms.
13	XIII.	Male	25	5th day	Right groin, right axilla.	60 c.c. in 3 doses	On the 7th day of disease, and 7 hours after last injection.	Lung symptoms.
14	XIV.	Male	15	3rd day	Right femoral region.	40 c.c. in 2 doses	On the 4th day of disease, about 12 hours after last injection.	Respiration went up to 148 before death. No lung symptoms.
15	XV.	Female	55	?	None	40 c.c. in 2 doses	24 hours after last injection.	Very violent delirium. No lung symptoms.
16	XVI.	Female	50	2nd day	Left axilla	40 c.c. in 2 doses	- - - - -	Recovered. Mild case, so that no serum was thought necessary after 2nd day of treatment. No lung symptoms.
17	XVII.	Female	28	2nd day	Right groin	60 c.c. in 3 doses	On the 4th day of disease.	No lung symptoms.
18	XVIII.	Female	60	7th day	Left groin	20 c.c. in 1 dose	On the 7th day of disease, about 12 hours after injection.	Practically moribund when inoculated. Congestion of both lungs at bases.
19	XIX.	Male	11	6th day	Left femoral glands.	30 c.c. in 2 doses	- -	Recovered. No suppuration. No lung symptoms.
20	XX.	Male	35	6th day	Right femoral region	20 c.c. in 1 dose	On the 6th day of disease, about 3 hours after inoculation.	No lung symptoms.
21	XXI.	Female	25	9th day	Left axilla, left popliteal space.	50 c.c. in 2 doses	On the 10th day of disease, 5 hours after last injection.	Patient had aborted 4 days before admission. Secondary pneumonia (?) Injected the morning after her admission to hospital.
22	XXII.	Female	11	2nd day	Left axilla	55 c.c. in 3 doses	On the 4th day of disease, about 12 hours after last injection.	The temperature in this case never went below 103° F., except once. No lung symptoms.
23	XXIII.	Female	13	5th day	Left submaxillary region.	40 c.c. in 2 doses	On the 6th day of disease, less than 24 hours after last injection.	No lung symptoms.
24	XXIV.	Female		2nd day	Right submaxillary region.	75 c.c. in 4 doses	- - -	Recovered. No suppuration. No lung symptoms.

Serial No.	Reference to Detailed Notes.	Sex.	Age.	Date of Disease on which Serum first Injected.	Situation of Bubo.	Quantity of Serum Injected.	Date of Disease, or Period after Injection, at which Death occurred in Fatal Cases.	Remarks.
25	APP. LXXIX. XXV.	Female	25	6th day	No bubo	20 c.c. in 1 dose	On the 10th day of disease, and 4 days after inoculation.	Doubt as to the diagnosis of plague. Patient had lung symptoms.
26	XXVI.	Male	27	2nd day	Left groin	110 c.c. in 5 doses	On the 5th day of disease	Delirium was very marked throughout. No lung symptoms.
27	XXVIII.	Female	25	4th day	Right axilla	70 c.c. in 3 doses	- - - -	Recovered. No lung symptoms. No suppuration.
28	XXIX.	Female	2	?	None	15 c.c. in 1 dose	A few hours after admission and inoculation.	No lung symptoms.
29	XXX.	Male	An aged man.	5th day	Right groin and left side of neck.	100 c.c. in 4 doses	On the 8th day of disease, 3 days after first injection and about 16½ hours after the last.	Very serious case from the first. No lung symptoms.
30	XXXI.	Male	18	6th day	Right epitrochlear gland.	60 c.c. in 2 doses	On the 7th day of disease, and same day as last injection.	Secondary lung symptoms, first noticed on the left side, pneumonia gradually invading the right lung.
31	XXXII.	Female	35	6th day	Left femoral region.	40 c.c. in 1 dose	On the 7th day of disease, and 20 hours after inoculation.	No lung symptoms.
32	XXXIII.	Female	55	A few hours after first symptoms set in, patient being an inmate of hospital.	No bubo	60 c.c. in 2 doses within 24 hours of onset of disease.	On the 12th day of disease, and 12th day after incoulation.	Patient died rather suddenly, probably from œdema of lungs(?) No sputum could be obtained.
33	XXXIV.	Male	14	5th day	No bubo	60 c.c. in 2 doses	- - - -	Recovered. No lung symptoms. Was injected the morning after admission to hospital.
34	XXXV.	Male	10	3rd day	Right groin, left axilla.	20 c.c. in 1 dose	- - - -	Recovered. Buboes had to be opened. The bubo in left axilla developed on day following injection of serum. No lung symptoms.
35	XXXVI.	Female	25	7th day	Left groin	100 c.c. in 4 doses	- - - -	Recovered. Slight lung symptoms.
36	XXXVII.	Female	30	4th day	Left groin	160 c.c. in 7 doses on 7 consecutive days.	On the 11th day of disease, and on day following last injection.	Had a few sibilant rales in chest.
37	XXXVIII.	Male	60	1st day	Left groin	100 c.c. in 4 doses	On the 5th day of disease, and 1¾ hours after last injection.	No lung symptoms.
38	XXXIX.	Female	15	6th day	Submaxillary region.	100 c.c. in 4 doses on 6th, 7th, 8th, and 9th day of disease.	On the 17th day of disease, and 8 days after last injection.	The patient was doing fairly well when signs of pneumonia set in, and she died in 24 hours Bubo was opened.
39	XL.	Female	20	4th day	Left axilla	40 c.c. in 1 dose	- - - -	Recovered. Case was never severe. No lung symptoms.
40	XLI.	Male	50	5th day	?	40 c.c. in 1 dose	On the 6th day of disease, 14 hours after injection.	Lung symptoms, probably pneumonia. Was injected the morning after admission to hospital.
41	XLII.	Female	35	6th day	Right groin	60 c.c. in 2 doses	On the 10th day of disease, and 3 days after last injection.	Patient was 6 months pregnant, and aborted. No lung symptoms. Was injected the morning after admission to hospital.
42	XLIII.	Female	30	3rd day	Right cervical glands.	40 c.c. in 1 dose	On the 4th day of disease, about 12 hours after injection.	No lung symptoms. Was injected the morning after admission to hospital.
43	XLIV.	Female	?	3rd day	Right axilla	40 c.c. in 1 dose	- - - -	Recovered. No lung symptoms. Was never a severe case.
44	IA.	Male	3	3rd day	Right axilla	20 c.c. in 1 dose	- - - -	Recovered. No lung symptoms. Bubo suppurated.
45	IIA.	Female	13	5th day	Left side of neck.	20 c.c. in 1 dose	- - - -	Recovered. No lung symptoms Was never a severe case.
46	IIIA.	Female	2½	4th day	Left groin	20 c.c. in 1 dose	- - - -	Recovered. Condition was good from the first. No lung symptoms.
4	IVA.	Male	35	5th day	Left groin	100 c.c. in 4 doses	- - - -	Recovered. No lung symptoms. Bubo suppurated. Was injected the morning after admission to hospital.
48	VA.	Male	21	4th day	Left side of neck.	140 c.c. in 6 doses on 3 days.	On the 7th day of disease, and 19 hours after last injection.	No lung symptoms.
4	VIA.	Male	50	6th day	Left groin	40 c.c. in 1 dose	- - - -	Recovered. No lung symptoms. Condition good from the first. Was injected the morning after admission to hospital.
50	APP. LXXX. I.	Male	28	3rd day	Right femoral region.	160 c.c. in 7 doses on 4 days.	On the 7th day of disease, 5 days after first injection, and about 24 hours after the last.	No lung symptoms. Retention of urine.
51	II.	Male	35	4th day	Left groin	140 c.c. in 6 doses on 4 days.	On the 8th day of disease, 4 days after the first, and less than 24 hours after the last.	No lung symptoms.

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Serial No.	Reference to Detailed Notes.	Sex.	Age.	Date of Disease on which Serum first Injected.	Situation of Bubo.	Quantity of Serum Injected.	Date of Disease, or Period after Injection, at which Death occurred in Fatal Cases.	Remarks.
52	App. LXXX. III.	Male	28	3rd day	Left groin	60 c.c. in 1 dose	On the 3rd day of disease, about 12 hours after injection.	No lung symptoms.
53	IV.	Male	30	3rd day	Left groin	140 c.c. in 6 doses on 4 consecutive days.	- - - -	Recovered. Glands necrosed and had to be removed. Patient had cough, with rales in right lung.
54	V.	Male	40	3rd day	Left inguinal region.	100 c.c. in 3 doses on 3 consecutive days.	On the 5th day of disease, 2 days after 11th injection, and shortly after last.	Prolonged expiration and rhonchi over both lungs.
55	VI.	Male	30	4th day	Right sub-maxillary. region.	100 c.c. in 4 doses on 4th and 5th day of disease.	On the 7th day of disease, 3 days after 1st, and and about 36 hours after the last injection.	Respiration extremely rapid towards the end. No lung symptoms.
56	VII.	Male	30	5th day	Left femoral region.	40 c.c. in 1 dose	On the 5th day of disease, a few hours after injection.	Lungs normal.
57	VIII.	Male	25	5th day	Right groin	115 c.c. in 5 doses on 3 consecutive days.	- - - -	Recovered. Rhonchi at base of right lung. Bubo incised.
58	IX.	Male	24	5th day	Right axilla	150 c.c. in 6 doses on 3 consecutive days.	On the 8th day of disease, 3 days after the 1st injection, and less than 24 hours after the last.	Lungs normal.
59	X.	Male	40	4th day	Left axilla	120 c.c. in 5 doses on 3 consecutive days.	On the 7th day of disease, 3 days after 1st, and on day following last injection.	Was injected on the day after admission to hospital. Rales and rhonchi over both lungs.
60	XI.	Male	25	3rd day	Right femoral region, Left groin.	160 c.c. in 7 doses on 4 consecutive days.	On the 6th day of disease, 4 days after the 1st, and a few hours after the last injection.	Lungs normal. The gland in left groin became affected on the 3rd day of serum treatment.
61	XII.	Male	24	3rd day	Left axilla	80 c.c. in 3 doses on 2 days.	On the 5th day of disease, 2 days after 1st, and a few hours after last injection.	Sibilant rhonchi over both lungs.
62	XIII.	Male	30	3rd day	Right groin	60 c.c. in 3 doses on 2 consecutive days.	On the 4th day of disease	Lungs normal.
63	XIV.	Male	25	4th day	Right groin	40 c.c. in 1 dose	On the 4th day of disease, a few hours after injection.	Bronchial breathing over the whole of the left lung.
64	XV.	Male	25	3rd day	Right femoral region.	135 c.c. in 6 doses on 4 consecutive days.	On the 6th day of disease, about 12 hours after the last injection.	Prolonged expiration at both bases of lungs with rhonchi at end of expiration.
65	App. LXXXI I.	Male	23	7th day	Left axilla	175 c.c. in 8 doses on 6 consecutive days.	- - - -	Recovered. Lungs normal. Retention of urine.
66	II.	Male	28	4th day	Right axilla	58 c.c. in 2 doses	On the 4th day of disease, the same day as the two injections.	Lungs normal. Was injected on the day after his admission to hospital.
67	III.	Male	40	3rd day	Right femoral region.	60 c.c. in 2 doses, of which 20 c.c. were injected in subcutaneous vein.	On the 4th day of disease, on day of injection.	Rales and rhonchi at bases of both lungs. Was injected the day after admission to hospital.
68	IV.	Male	45	4th day	Left groin	40 c.c. in 2 doses on the same day.	On the 5th day of disease, about 15 hours after last injection.	Lungs on both sides affected.
69	V.	Male	18	?	Right axilla	235 c.c. in 6 doses on 3 consecutive days.	Died 3 days after 1st injection, and on day of last injection.	Lungs normal.
70	VI.	Male	30	9th day	Right groin	140 c.c. in 5 doses on 3 consecutive days.	- - - -	Recovered. The bubo was already ulcerated when serum was injected. The lungs were full of rales, and patient had paroxysms of coughing.
71	VII.	Male	35	5th day	Right groin	40 c.c. in 1 dose	On the 5th day of disease, 5 hours after injection.	Lungs normal.
72	VIII.	Male	22	3rd day	Right femoral region.	135 c.c. in 6 doses on 3 consecutive days.	On the 6th day of disease, 3 days after 1st injection, and about 15 hours after last injection.	Chest full of rales. Cough troublesome.
73	IX.	Male	29	4th day	Left femoral region.	220 c.c. in 10 doses on 5 consecutive days.	- - - -	Recovered. Cough and expectoration. Rales both sides of chest.
74	X.	Male	30	4th day	Right axilla	80 c.c. in 3 doses on 2 consecutive days.	On the 5th day of disease	Patches of pneumonia at bases of both lungs. Patient was injected the day after his admission to hospital.
75	XI.	Male	14	7th day	Left groin	80 c.c. in 3 doses, on 2 consecutive days.	On the 8th day of disease	Slight lung symptoms.
76	XII.	Male	25	3rd day	Right axilla	80 c.c. in 3 doses on 2 consecutive days.	On the 4th day of disease	No lung symptoms.
77	XI.	Male	12	5th day	Left axilla	40 c.c. in 1 dose	On the 5th day of disease, about 6 hours after injection.	Lungs slightly affected on the left side.

TABLE showing the AMOUNTS of SERUM administered on each day of SERUM TREATMENT to the PATIENTS particularised in the Table above.

Serial No. (as in table immediately preceding).	Doses and Days of Treatment.							Total Amount of Serum injected.	Result.
	1st Day.	2nd Day.	3rd Day.	4th Day.	5th Day.	6th Day.	7th Day.		
1	20 c.c.	15 c.c.	—	—	—	—	—	35 c.c.	Death.
2	20 c.c.	—	—	—	—	—	—	20 c.c.	Death.
3	20 c.c.	—	—	—	—	—	—	20 c.c.	Death.
4	16 c.c.	10 c.c.	10 c.c.	20 c.c.	—	—	—	56 c.c.	Death.
5	10 c.c.	10 c.c.	—	—	—	—	—	20 c.c.	Death.
6	20 c.c.	10 c.c.	10 c.c.	—	—	—	—	40 c.c.	Recovery.
7	17 c.c.	—	—	—	—	—	—	17 c.c.	Death.
8	13 c.c. 10 c.c.	—	—	—	—	—	—	23 c.c.	Recovery.
9	10 c.c.	—	—	—	—	—	—	10 c.c.	Recovery.
10	17 c.c.	—	—	—	—	—	—	17 c.c.	Death.
11	20 c.c.	20 c.c.	10 c c.	—	20 c.c.	20 c.c.	—	90 c.c.	Recovery.
12	15 c.c.	15 c.c.	15 c.c.	—	—	—	—	45 c.c.	Death.
13	20 c.c.	20 c.c.	20 c.c.	—	—	—	—	60 c.c.	Death.
14	20 c.c.	20 c.c.	—	—	—	—	—	40 c.c.	Death.
15	20 c.c.	20 c.c.	—	—	—	—	—	40 c.c.	Death.
16	20 c.c.	20 c.c.	—	—	—	—	—	40 c.c.	Recovery.
17	20 c.c.	20 c.c.	20 c.c.	—	—	—	—	60 c.c.	Death.
18	20 c.c.	—	—	—	—	—	—	20 c.c.	Death.
19	15 c.c.	15 c.c.	—	—	—	—	—	30 c.c.	Recovery.
20	20 c.c.	—	—	—	—	—	—	20 c.c.	Death.
21	30 c.c.	20 c.c.	—	—	—	—	—	50 c.c.	Death.
22	15 c.c.	20 c.c.	20 c.c.	—	—	—	—	55 c.c.	Death.
23	20 c.c.	20 c.c.	—	—	—	—	—	40 c.c.	Death.
24	15 c.c.	20 c.c.	20 c.c.	20 c.c.	—	—	—	75 c.c.	Recovery.
25	20 c.c.	—	—	—	—	—	—	20 c.c.	Death.
26	30 c.c.	20 c.c.	20 c.c.	20 c.c.	20 c c.	—	—	110 c.c.	Death
27	30 c.c.	20 c.c.	20 c.c.	—	—	—	—	70 c.c.	Recovery.
28	15 c.c.	—	—	—	—	—	—	15 c.c.	Death.
29	40 c.c.	20 c.c. 20 c.c.	—	20 c.c.	—	—	—	100 c.c.	Death.
30	40 c.c.	20 c.c.	—	—	—	—	—	60 c.c.	Death.
31	40 c.c.	—	—	—	—	—	—	40 c.c.	Death.
32	40 c.c.	20 c.c.	—	—	—	—	—	60 c.c.	Death.
33	40 c.c.	20 c.c.	—	—	—	—	—	60 c.c.	Recovery.
34	20 c.c.	—	—	—	—	—	—	20 c.c.	Recovery.
35	40 c.c.	20 c.c.	20 c.c.	20 c.c.	—	—	—	100 c.c	Recovery.
36	40 c c.	20 c.c.	20 c.c.	20 c.c.	20 c.c.	20 c.c.	20 c.c.	160 c.c.	Death.
37	40 c.c.	20 c.c.	20 c.c.	20 c.c.	—	—	—	100 c.c.	Death.
38	40 c.c.	20 c.c.	20 c.c.	20 c.c.	—	—	—	100 c.c.	Death from pneumonia some time after serum treatment closed.
39	40 c.c.	—	—	—	—	—	—	40 c.c.	Recovery
40	40 c.c.	—	—	—	—	—	—	40 c.c.	Death.
41	40 c.c.	20 c.c.	—	—	—	—	—	60 c.c.	Death.
42	40 c.c.	—	—	—	—	—	—	40 c.c.	Death.
43	40 c.c.	—	—	—	—	—	—	40 c.c.	Recovery.
44	20 c.c.	—	—	—	—	—	—	20 c.c.	Recovery.
45	20 c.c.	—	—	—	—	—	—	20 c.c.	Recovery.
46	20 c.c.	—	—	—	—	—	—	20 c.c.	Recovery.
47	40 c.c.	20 c.c.	20 c.c.	20 c.c.	—	—	—	100 c.c.	Recovery.
48	40 c.c. 20 c.c.	20 c.c. 20 c.c.	20 c.c. 20 c.c.	—	—	—	—	140 c.c.	Death.
49	40 c.c.	—	—	—	—	—	—	40 c.c.	Recovery.
50	40 c.c. 20 c.c.	20 c.c. 20 c.c.	20 c.c. 20 c.c.	20 c.c.	—	—	—	160 c.c.	Death.
51	40 c.c.	20 c.c. 20 c.c.	20 c.c. 20 c.c.	20 c.c.	—	—	—	140 c.c.	Death.
52	60 c.c.	—	—	—	—	—	—	60 c.c.	Death.
53	40 c.c.	20 c.c. 20 c.c.	20 c.c. 20 c.c.	20 c.c.	—	—	—	140 c.c.	Recovery.

Serial No. (as in table immediately preceding).	Doses and Days of Treatment.						Total Amount of Serum injected.	Result.
	1st Day.	2nd Day.	3rd Day.	4th Day.	5th Day.	6th Day.		
54	40 c.c.	20 c.c.	40 c.c.	—	—	—	100 c.c.	Death.
55	40 c.c. 20 c.c.	20 c.c. 20 c.c.	—	—	—	—	100 c.c.	Death.
56	40 c.c.	—	—	—	—	—	40 c.c.	Death.
57	40 c.c.	20 c.c. 15 c.c.	20 c.c. 20 c.c.	—	—	—	115 c.c.	Recovery.
58	40 c.c. 30 c.c.	20 c.c. 20 c.c	20 c.c. 20 c.c.	—	—	—	150 c.c.	Death.
59	40 c.c. 20 c.c.	20 c.c. 20 c.c.	20 c.c.	—	—	—	120 c.c.	Death.
60	40 c.c. 20 c.c.	20 c.c. 20 c.c.	20 c.c. 20 c.c.	20 c.c.	—	—	160 c.c.	Death.
61	40 c.c.	20 c.c. 20 c.c.	—	—	—	—	80 c.c.	Death.
62	40 c.c. 20 c.c.	20 c.c.	—	—	—	—	80 c.c.	Death.
63	40 c.c.	—	—	—	—	—	40 c.c.	Death.
64	35 c.c. 20 c.c.	20 c.c. 20 c.c.	20 c.c.	20 c.c.	—	—	135 c.c.	Death
65	40 c.c.	20 c.c. 15 c.c.	20 c.c. 20 c.c.	20 c.c.	20 c.c.	20 c.c.	175 c.c.	Recovery.
66	40 c.c. 18 c.c.	—	—	—	—	—	58 c.c.	Death.
67	40 c.c. 20 c.c.	—	—	—	—	—	60 c.c.	Death.
68	20 c.c. 20 c.c.	—	—	—	—	—	40 c.c.	Death.
69	40 c.c. 35 c.c.	40 c.c. 40 c.c.	40 c.c. 40 c.c.	—	—	—	235 c.c.	Death.
70	40 c.c.	40 c.c. 20 c.c.	20 c.c. 20 c.c.	—	—	—	140 c.c.	Recovery.
71	40 c.c.	—	—	—	—	—	40 c.c.	Death.
72	20 c.c. 15 c.c.	40 c.c. 20 c.c.	20 c.c. 20 c.c.	—	—	—	135 c.c.	Death.
73	40 c.c. 20 c.c.	20 c.c. 20 c.c.	20 c.c. 20 c.c.	20 c.c. 20 c.c.	20 c.c. 20 c.c.	—	220 c.c.	Recovery.
74	40 c.c. 20 c.c.	20 c.c.	—	—	—	—	80 c.c.	Death.
75	40 c.c. 20 c.c.	20 c.c.	—	—	—	—	80 c.c.	Death.
76	40 c.c. 20 c.c.	20 c.c.	—	—	—	—	80 c.c.	Death.
77	40 c.c.	—	—	—	—	—	40 c.c.	Death.

V.—(B.) *Results obtained by Captain Mason, R.A.M.C., by the Employment of Yersin's Serum during the Epidemic in Cutch.*

Source of the serum used in Cutch Mandvi.

Para. 503 in this Chapter.

532. Captain Mason, R.A.M.C., has reported to us the particulars of a series of systematic observations which he made on plague patients with Yersin's anti-plague serum obtained direct from the Pasteur Institute, Paris. In the case of one of the consignments of serum which were furnished to him, he made also a series of experiments on animals. The results of the experiments have been set forth in an earlier part of this Chapter.

Method of administration.

27,034.

27,055.

27,195.

The serum was administered to human plague patients in doses of from 10 to 60 c.c. The smaller doses were employed in the cases first treated, the larger doses being resorted to as experience was gained. Quantities larger than 60 c.c. were not administered, because it was found that with this last dose the patients began to suffer from painful swelling of the joints.

Principle on which the patients were selected for treatment.

27,024; 27,153.

The patients who were therapeutically treated with serum were drawn from several hospitals. All classes of patients were submitted to the treatment, with the exception of patients admitted five or more days after they had fallen ill. In a very few instances the treatment was extended also to these.

Statistics of cases treated by Captain Mason and of controls.

533. The results which were obtained in the case of 100 patients treated with the serum were compared by Captain Mason with the results obtained in 100 untreated patients. The results of this comparison are shown in the following table :—

Comparison of 100 serum cases and 100 control cases.

COMPARISON INSTITUTED BY CAPTAIN MASON, R.A.M.C., AS BETWEEN 100 SERUM CASES AND 100 CONTROL CASES.

27,028.

—	Cases.	Deaths.	Case-Mortality.
Control Group - - -	100	83	83 per cent.
Serum Group - - -	100	59	59 per cent.
Difference in favour of the serum cases - - - -			24 per cent.

Critical consideration of the above statistics.

In determining the value which is to be placed on the results of the above comparison, it is important to take into consideration the following. The plague cases that served as controls were admitted to the Brahmapuri Hospital at Cutch Mandvi during the period of eight days (from the 25th of May to the 2nd of June 1897) at the height of the epidemic, when the fatality of the disease was extreme as is evidenced by the 27,146–9.
mortality of 83 per cent. in the hospital. The plague cases, however, which were treated with serum were, with the exception of the first 5 cases treated, admitted to hospital during a period of four months of a declining epidemic, when we may presume the type of the disease to have been much milder. Again, only 31 of the 100 serum cases were admitted into the Brahmapuri Hospital, this, apparently, being in consequence of the decline of the epidemic in Cutch Mandvi. The remaining 69 cases were admitted into hospital in smaller places in the neighbourhood of Cutch Mandvi. The serum cases were thus hardly comparable with the control cases. It is, indeed, recognised by Captain Mason that the average severity of the disease in the control cases was greater than that of the serum cases. Captain Mason was, however, not in 27,151–2–4.
a position to put forward any other series of control cases which complied more strictly with the required conditions.

Comparison of the serum and control cases treated in the Brahmapuri Hospital.

Failing a series of serum cases treated under similar conditions with the control cases, we may compare the 31 cases which were treated with serum in the Brahmapuri Hospital with the 100 control cases which were, as we saw, admitted into that hospital. The results of this comparison are expressed in the following table :—

COMPARISON BETWEEN 31 SERUM CASES TREATED IN THE BRAHMAPURI HOSPITAL, CUTCH MANDVI, AND 100 CASES IN THE SAME HOSPITAL NOT TREATED WITH SERUM.

—	Cases.	Deaths.	Case-Mortality.
Control Cases - - - -	100	83	83 per cent.
Serum Cases - - -	31	20	63 per cent.
Difference in favour of the serum cases - - - -			20 per cent.

The comparison thus instituted is somewhat less favourable to the serum treatment than the comparison instituted by Captain Mason. Even more unfavourable to the serum treatment becomes the comparison if we compare the results obtained in the control cases with the results obtained in the serum cases treated contemporaneously, or within a week after the date when the last control case was admitted. The comparison would then be as follows :—

COMPARISON BETWEEN 100 CONTROL CASES IN THE BRAHMAPURI HOSPITAL AND THE SERUM CASES THAT WERE TREATED IN THE SAME HOSPITAL IN OR ABOUT THE SAME PERIOD.

—	Cases.	Deaths.	Case-Mortality.
Control Group - - - -	100	83	83 per cent.
Serum Group - - -	19	14	75 per cent.

Difference in favour of the serum cases - - - - 8 per cent.

In view of the more unfavourable results arrived at by these last comparisons, it is obviously possible that the diminished mortality of the serum cases which is exhibited in the first table may be referable quite as much to the decline in the virulence of the epidemic as to an effect exerted by the serum treatment.

Effect of the serum treatment on clinical symptoms in cases treated at Cutch Mandvi.
Effect on temperature.

27,050.
27,052.

534. We pass now from considering the influence exerted on case-mortality, to consider whether the symptoms of the disease were modified by the exhibition of the serum. Captain Mason's testimony on this question is quite unequivocal. He tells us that patients became calmer on treatment with the serum, their temperature fell, and there was a general amelioration in their condition. "It is certain," says this clinical observer, "that in ordinary cases the temperature falls under the action of the first injection, and it is equally certain that in many cases it never reascends; the fall of the temperature is obtained whatever the day of the disease on which the treatment is commenced." On the other hand, Captain Mason tells us that "the improvement in the general condition, like the fall in temperature, is in the majority of the gravest cases apt to be transitory: the symptoms again become serious and the disease appears to run its course as if the serum had not been given."

No effect on development of secondary buboes.

Para. 536 below.

Do.

It does not, however, appear from the clinical notes tendered by Captain Mason that the injection of serum prevented the appearance of secondary buboes. In one of Captain Mason's cases (Case No. 85) the patient, although injected on the first day of the disease, developed a secondary left submaxillary bubo and a secondary popliteal bubo on the third day, and died on the fifth day, while in another of the cases (Case No. 98) the patient who was injected on the second day of the disease developed buboes in the right and left groins three days afterwards, though his case ended in recovery.

No effect on primary plague pneumonia.

It is clear, from Captain Mason's notes, that the serum exerted no beneficial effect on cases of primary plague pneumonia.

Effect of the serum treatment according to the date of the disease on which treatment was commenced.

Lastly, we may make a comparison between the course of the disease in patients treated with the serum with the course of the disease in control patients, with a view to determining whether the patients who were admitted and treated with serum in the early stages of the disease compare more favourably with their corresponding control patients than those admitted and treated with serum in the later stages of the disease do with their respective controls. At the same time we may compare the serum cases among themselves, with a view to determining whether the case-mortality was less in those which were treated early as compared with the cases which were treated late. The data for these comparisons are set forth in the following table :—

—	1st Day.		2nd Day.		3rd Day.		4th Day.		6th Day or later.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Control Group - - -	*19*	*14*	*41*	*32*	*21*	*20*	*15*	*11*	*3*	*3*
Case-mortality of this group	1 in 1·3		1 in 1·3		1 in 1, nearly		1 in 1·4		1 in 1	
Serum Group - - -	*27*	*15*	*47*	*30*	*17*	*8*	*8*	*4*	*1*	*1*
Case-mortality of this group	1 in 1·8		1 in 1·6		1 in 2·1		1 in 2		1 in 1	

It will be seen that the case-mortality on each day was smaller in the cases treated with serum than in the untreated cases. On the other hand, the cases admitted and treated with serum on the first and second days do not compare more favourably with the control cases admitted on those days than do the cases admitted and treated on the third and fourth days when contrasted with the control cases admitted on those days. The figures thus supply no evidence that the serum exerts a greater beneficial influence when administered early than when administered late. The same inference can be drawn from a comparison of the serum cases among themselves. This last comparison is, however, as has been shown in a previous section of this Chapter, so complicated with fallacies as to be of comparatively small value.

Para. 525 of this Report.

Conclusion regarding value of serum treatment in Cutch Mandvi.

535. It would seem, in view of what has been said above, that we cannot do otherwise than conclude that the statistics furnished by Captain Mason, R.A.M.C., are inconclusive as to the value of the serum employed by him. At the same time, we are disposed to think that the favourable impression which was created on the mind of Captain Mason by his observation of the clinical effects of the serum treatment furnishes a presumption in favour of the utility of Yersin's serum.

Details of cases treated with serum at Cutch Mandvi.

536. Finally we reprint from Captain Mason's evidence a table giving details with regard to the cases of plague treated with Yersin's serum in Cutch Mandvi and the neighbourhood.

27,028.

Hospital in which treated.	No.	Sex.	Age.	Admitted to Hospital.	How long ill when injected.	Total Quantity injected.	Result.	Bubo.	Remarks.
				1897.			1897.		
Brahmapuri Mandvi.	1	Male	9	30.5	4 days -	90 c.c.	Discharged -	Parotid, left groin, left cervical.	
„	2	„	35	„	4 „ -	105 „	Died, 4.6 -	Right axilla -	Not injected till 4th May.
„	3	Female	15	1.6	1 day -	120 „	„ 3.6 -	„ „	
„	4	Male	8	„	2 days -	210 „	„ 11.6 -	Right inguinal and femoral.	
„	5	Female	32	2.6	2 „ -	220 „	Discharged, 11.6.	Right groin, plague pustule left foot.	
„	6	„	13	„	4 „ -	190 „	Died, 6.6 -	Left femoral, right and left feet swollen, right and left cervical.	
„	7	Male	8	„	1 day -	50 „	„ 4.6 -	Left axilla.	
„	8	Female	40	3.6	2 days -	140 „	„ 5.6 -	Left femoral.	
„	9	„	45	4.6	2 „ -	170 „	„ 11.6 -	Right groin.	
„	10	„	29	„	2 „ -	200 „	„ 23.6 -	Left femoral (pneumonia).	
„	11	„	30	„	1 day -	160 „	Discharged, 11.6.	Left groin.	
„	12	„	20	„	1 „ -	100 „	Discharged -	Nil.	
„	13	„	40	„	1 „ -	140 „	Died, 9.6 -	Left femoral.	
„	14	Male	40	4.6	2 days -	230 „	„ 8.6 -	Nil.	
„	15	„	45	5.6	2 „ -	170 „	„ 9.6 -	Right inguinal, suppression of urine.	
„	16	Female	28	6.6	2 „ -	230 „	„ 13.6 -	Right groin (pneumonia).	
„	17	„	25	7.6	3 „ -	140 „	„ 11.6 -	Left groin.	
„	18	„	60	9.6	3 „ -	120 „	„ 12.6 -	Right axilla.	
„	19	Male	60	„	4 „ -	100 „	Discharged, 19.6.	Left groin.	
„	20	Female	21	11.6	3 „ -	40 „	Discharged, 19.6.	Right groin.	
„	21	„	30	15.6	3 „ -	90 „	Discharged -		
„	22	„	10	„	3 „ -	100 „	„ -		
„	23	„	33	„	1 day -	150 „	Died - -		
„	24	„	45	22.6	2 days -	120 „	„ - -	Left submaxillary.	
„	25	Male	55	23.6	1 day -	150 „	„ - -	Right groin.	
„	26	„	50	„	1 „ -	90 „	Discharged -	Left axilla.	
„	27	Female	18	19.6	2 days -	110 „	„ -	Left groin.	
„	28	„	17	„	2 „ -	10 „	„ -	„ „ -	Severe central intoxication. Bilious vomiting. Sputa typical.
„	29	Male	20	3.7	2 „ -	80 „	Died - -	„ „	
„	30	Female	18	5.7	2 „ -	75 „	„ - -	Right axilla.	
„	31	„	12	„	2 „ -	100 „	„ - -	Tenderness both groins.	
„	32	„	105	14.7	4 „ -	70 „	„ - -	Left groin.	
Gundiala	33	„	7	4.8	1 day -	45 „	Discharged, 6.8.	Nil - -	Swelling and tenderness in right groin.
„	34	„	10	„	1 „ -	50 „	Discharged, 6.8.	„	
„	35	„	40	6.8	1 „ -	100 „	Died, 8.8 -	„	

Hospital in which treated.	No.	Sex.	Age.	Admitted to Hospital.	How long ill when injected.	Total Quantity injected.	Result.	Bubo.	Remarks.
Gundiala	36	Male	11	1897. 6.8	1 day -	30 c.c.	1897. Died, 7.8 -	Nil - -	Passed round worms.
,,	37	Female	11	,,	1 ,, -	120 ,,	,, 9.8 -	Left inguinal.	
,,	38	,,	25	4.8	4 days -	95 ,,	Discharged, 13.8.	Right axilla.	
,,	39	,,	7	10.8	3 ,, -	70 ,,	Discharged, 13.8.	Left inguinal.	
,,	40	Male	14	16.8	1 day -	80 ,,	Died, 18.8 -	Nil - -	
,,	41	Female	11	,,	1 ,, -	100 ,,	,, 13.8	Left and right groin, right axilla.	
,,	42	Female	9	16.8	1 ,, -	80 ,,	,, 16.8 -	Right groin.	
,,	43	,,	—	17.8	2 days -	110 ,,	,, 18·8 -	Nil - -	Pemphigoid rash on face and back.
,,	44	Male	30	19.8	2 ,, -	130 ,,	,, 22.8 -	Left inguinal.	
,,	45	,,	50	,,	3 ,, -	180 ,,	,, 24.8 -	Right groin.	
,,	46	Female	—	17.8	2 ,, -	80 ,,	,, 20.8 -	,, ,,	
,,	47	Male	28	20.8	2 ,, -	130 ,,	,, 24.8 -	Left inguinal.	
,,	48	Female	9	17.8	3 ,, -	100 ,,	,, 22.8 -	Right axilla, right cervical, left cervical, left axilla, right and left inguinal.	
,,	49	Male	—	18.8	2 ,, -	140 ,,	,, 21.8 -	Right groin.	
,,	50	,,	14	13.8	1 day -	120 ,,	Discharged, 30.8.	Right axilla.	
,,	51	Female	10	15.8	1 ,, -	100 ,,	Discharged, 2.9.	Left groin.	
,,	52	Male	11	10.8	1 ,, -	100 ,,	Discharged, 30.8.	Right and left groin.	
,,	53	,,	—	15.8	1 ,, -	130 ,,	Died, 19.8 -	Left axilla and right groin.	
,,	54	Female	22	16.8	4 days -	160 ,,	,, 28.8 -	Nil - - -	Muscular rheumatism, secondary pneumonia.
,,	55	,,	10	17.8	2 ,, -	130 ,,	Discharged, 2.9.	Right axilla, right inguinal.	Secondary, right leg, and synovitis.
,,	56	Male	7	19.8	3 ,, -	100 ,,	Discharged, 2.9.	Left groin and left cervical.	Secondary.
,,	57	,,	12	20.8	2 ,, -	100 ,,	Died, 25.8 -	Left inguinal.	
,,	58	,,	9	23.8	1 day -	120 ,,	Discharged, 2.9.	Left cervical, and tenderness both groins.	
,,	59	Female	9	24.8	3 days -	100 ,,	Discharged, 1.9.	Right inguinal -	Absorbed.
,,	60	Male	4	26.8	2 ,, -	40 ,,	Discharged, 2.9.	Nil.	
,,	61	Female	13	,,	2 ,, -	100 ,,	Discharged, 2.9.	Left axilla.	
,,	62	,,	40	,,	2 ,, -	120 ,,	Discharged, 2.9.	Right inguinal.	
,,	63	Male	7	28.8	2 ,, -	50 ,,	Discharged, 2.9.	Right femoral.	
,,	64	Female	40	,,	2 ,, -	130 ,,	Died, 31·8 -	Right inguinal.	
,,	65	Male	12	28.8	2 ,, -	45 ,,	,, 30·8 -	Left groin.	
,,	66	Female	—	17.8	2 ,,	129 ,,	Discharged, 27.8.	,, ,,	
,,	67	,,	—	—	1 day -	130 ,,	Discharged, 28.8.	Right groin.	
,,	68	Male	12	18.8	2 days -	100 ,,	Discharged, 5.9.	Left axilla.	
,,	69	Female	—	25.8	1 day -	160 ,,	Died, 29.8 -	Nil.	
,,	70	Male	—	28.8	3 days -	160 ,,	,, 29.8 -	,,	
,,	71	Female	20	27.8	2 ,, -	120 ,,	,, 29.8 -	Tenderness, right groin.	
,,	72	,,	12	28.8	2 ,, -	30 ,,	,, 30.8 -	Right axilla, with effusion.	
,,	73	Male	35	,,	2 ,, -	160 ,,	,, 2.9 -	Nil.	
,,	74	Female	45	,,	2 ,, -	160 ,,	,, 6.9 -	Left groin - -	Popliteal bubo, acute thrombosis of left femoral and popliteal and posterior tibial veins.
,,	75	Male	40	2.9	2 ,, -	150 ,,	,, 6.9 -	Left groin.	
,,	76	Female	10	6.9	6 ,, -	150 ,,	,, 6.9 -	Primary plague pneumonia.	
,,	77	,,	24	2.9	4 ,, -	120 ,,	Discharged, 14.9.	Effusion, right axilla.	
,,	78	,,	—	,,	2 ,, -	180 ,,	Discharged, 13.9.	Nil.	
,,	79	,,	8	,,	3 ,, -	60 ,,	Discharged, 14.9.	Left inguinal.	
,,	80	,,	60	5.9	2 ,, -	160 ,,	Discharged, 10.9.	Nil.	
,,	81	,,	40	,,	3 ,, -	150 ,,	Discharged, 15.9.	Left groin.	
,,	82	Male	50	,,	2 ,, -	220 ,,	Died, 10.9 -	Right axilla.	

Hospital in which treated.	No.	Sex.	Age.	Admitted to Hospital.	How long ill when injected.	Total Quantity injected.	Result.	Bubo.	Remarks.
Gundiala	83	Female	25	1897. 5.9	3 days	150 c.c.	1897. Died, 8.9	Nil	Primary plague pneumonia.
,,	84	,,	18	6.9	1 day	130 ,,	,, 8.9	Left inguinal.	
,,	85	,,	14	7.9	1 ,,	60 ,,	,, 11.9	Right groin	Left sub-poplitea bubo developed 9.9.97.
,,	86	,,	10	8.9	2 days	45 ,,	Discharged, 17.9.	Sub-clavicular	Bubo, left side, developed.
,,	87	,,	19	,,	3 ,,	90 ,,	Died, 9.9	Left groin	Eyes injected.
,,	88	,,	30	,,	2 ,,	110 ,,	,, 13.9	Left axilla.	
,,	89	,,	40	2.9	3 ,,	120 ,,	,, 8.9	Left inguinal	Primary plague pneumonia.
Merau	90	Female	—	5.9	1 day	90 ,,	Discharged, 18.9.	Left groin	
Gundiala	91	,,	35	,,	2 days	140 ,,	Discharged, 9.9.	Right inguinal.	
,,	92	,,	9	6.9	2 ,,	60 ,,	Died, 9.9	Right axilla	With effusion.
,,	93	Male	75	,,	2 ,,	160 ,,	,, 8.9	Nil.	
Merau	94	,,	25	,,	2 ,,	150 ,,	,, 9.9	,,	
,,	95	Female	50	7.9	2 ,,	120 ,,	,, 9.9	Right groin.	
,,	96	,,	24	8·9	1 day	170 ,,	,, 12.9	Glands parotid, left.	
,,	97	Male	30	11.9	3 days	80 ,,	Discharged, 20.9.	Left groin.	
Gundiala	98	,,	12	4.9	2 ,,	100 ,,	Discharged, 23.9.	Right cervical, right inguinal.	Right and left groins developed 9.9.97.
,,	99	Female	16	5.9	2	150 ,,	Discharged, 23.9.	Right inguinal.	
,,	100	,,	25	10.9	2 ,,	120 ,,	Discharged, 21·9.	Right abdominal.	

V.—(C) *Results obtained by Dr. Simond by the Administration of Yersin's Serum in Karad and Karachi and elsewhere.*

Particulars regarding Dr. Simond's operations with Yersin's serum.

537. The next observations which we have to consider with regard to the effect produced by the administration of Yersin's anti-plague serum are those of Dr. Simond. The sera employed were again sera which were prepared at the Pasteur Institute, Paris. Two series of observations were made—the first of these at Karad in September 1897, the second at Karachi between the 9th of May and the 6th of June 1898.

Observations of Dr. Simond in Karad. 21,106–17.

538. With regard to the observations made at Karad, we learnt from Captain Smith, I.M.S., particulars concerning 32 hospital patients treated by Dr. Simond. 27 of these 32 were bubonic cases. Only early cases—that is, cases in which the disease had not lasted more than four days—were chosen for serum treatment. So far as we could learn, the results of the serum cases were not compared with those obtained in any comparable series of control cases. The general results of the serum cases were as follows:—

Cases.	Deaths.	Case-Mortality.
32	21	65·5 per cent.

Failing information as to the case-mortality of a series of comparable control cases, or with respect to the gross case-mortality of the hospital for the period during which the serum was used, we are thrown back on the uncertain method of comparison between the serum cases treated respectively in the early and the later stages of the disease. The results of this comparison, when we take into consideration only the bubonic cases, were as follows:—

—	1st Day.		2nd Day.		3rd Day.		4th Day.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Number of cases and deaths	2	1	17	12	5	4	3	2
Case-mortality	1 in 2		1 in 1·4		1 in 1·2		1 in 1·5	

It is obvious that the case-mortalities, except possibly in the case of patients admitted on the 2nd day, can hardly be regarded as representative, inasmuch as they have been calculated on a very small number of cases. Again, examination of the records shows that the cases treated on the several days were, as far as we can judge, not comparable among themselves from the point of view of severity.

Details of cases treated with serum at Karad.

539. Finally we reproduce from the evidence of Captain Smith, I.M.S., a table showing the details of cases treated by Dr. Simond at Karad:—

21,109.

No.	Age.	Sex.	Nature of Disease.	Day of Disease on Admission.	Date of Admission.	Date of Death.	Amount of Serum injected.	Duration of Illness in Fatal Cases.	Date of Discharge in Cases that recovered.
1	9	Female	Right inguinal bubo and pneumonia. Very serious case.	2nd day	5.9.97	7.9.97	40 c.c. in 2 doses -	4 days.	—
2	7	Male	Axillary bubo and pneumonia on right side. Very serious case.	2nd day	5.9.97	5.9.97	15 c.c. 6 hours before death.	2 days.	—
3	32	„	Right inguinal bubo and swelling of parotid gland. Very serious case.	2nd day	5.9.97	6.9.97	60 c.c. in 2 doses -	3 days.	—
4	25	Female	Axillary bubo and cervical bubo. Very serious case.	3rd day	6.9.97	8.9.97	60 c.c. in 2 doses -	5 days.	—
5	50	Male	Double pneumonia. No buboes. Very serious case.	2nd day	6.9.97	9.9.97	90 c.c. in 4 doses -	5 days.	—
6	30	Female	Pneumonia on right side and small inguinal bubo. Aphasia. Very serious case.	2nd day	6.9.97	7.9.97	40 c.c. in 2 doses -	3 days.	—
7	39	Male	Right inguinal bubo. Mild case.	4th day	6.9.97	—	20 c.c. injected at patient's request, without there being any necessity for it.	—	5.10.97
8	50	Female	Cervical inguinal and axillary buboes. Very serious case.	3rd day	6.9.97	13.9.97	50 c.c. in 3 doses -	10 days.	—
9	14	„	Right inguinal bubo. Coma. Very serious case.	2nd day	7.9.97	13.9.97	30 c.c. in 2 doses -	8 days.	—
10	50	„	Cervical buboes and pneumonia. Very serious case.	3rd day	7.9.97	7.9.97	30 c.c. in 1 dose, 7 hours before death.	3 days.	—
11	21	„	Left inguinal bubo. Stupor. Aphonia. Very serious case.	2nd day	7.9.97	—	60 c.c. in 3 doses -	—	15.9.97
12	20	„	Cervical and inguinal bubo. Coma. Very serious case.	2nd day	7.9.97	10.9.97	80 c.c. in 3 doses -	5 days.	—
13	38	Male	Intestinal plague. No buboes or pneumonia. Aphasia. Very serious case.	1 day	8.9.97	10.9.97	20 c.c. - -	5 days.	—
14	30	„	No bubo or pneumonia. High fever. Doubtful case.	3rd day	8.9.97	—	40 c.c. in 2 doses -	—	6.10.97
15	24	Female	Axillary bubo and deep stupor. Very serious case.	2nd day	9.9.97	11.9.97	40 c.c. - -	4 days.	—
16	18	„	Inguinal bubo and absolute stupor. Very serious case.	2nd day	9.9.97	9.9.97	30 c.c. - -	2 days.	—
17	20	Male	Inguinal bubo. Delirium. Very serious case.	4th day	10.9.97	15.9.97	? - - -	9 days.	—
18	25	Female	Inguinal bubo. Case of average severity.	2nd day	10.9.97	—	40 c.c. in 2 doses -	—	5.10.97
19	20	„	Inguinal bubo. Very serious case.	2nd day	11.9.97	15.9.97	30 c.c. - -	6 days.	—
20	60	Male	Right inguinal bubo. Case of average severity.	2nd day	12.9.97	—	40 c.c. in 2 doses -	—	7.10.97
21	20	Female	Right and left inguinal buboes. Very serious case. Stupor and aphonia.	2nd day	14.9.97	—	80 c.c. in 3 doses -	—	17.11.97
22	18	„	Left inguinal bubo. Coma. Very serious case.	4th day	14.9.97	15.9.97	30 c.c. -	5 days.	—
23	30	Male	Inguinal bubo. Serious case.	2nd day	14.9.97	—	90 c.c. in 4 doses	—	12.10.97
24	50	„	No bubo. No pneumonia. High fever (105°). Doubtful case, possibly mild intestinal plague.	?	15.9.97	—	40 c.c. in 2 doses -	—	17.10.97

No.	Age.	Sex.	Nature of Disease.	Day of Disease on Admission	Date of Admission.	Date of Death.	Amount of Serum injected.	Duration of Illness in Fatal Cases.	Date of Discharge in Cases that recovered.
25	23	Male	Intestinal plague, without buboes or pneumonia. Very serious case, with stupor and delirium.	2nd day	16.9.97	22.9.97	70 c.c. in 3 doses -	8 days.	—
26	25	Female	Left inguinal bubo. Very serious case. Stupor and aphonia. Convulsions.	1st day	17.9.97	—	80 c.c. in 3 doses -	—	6.11.97
27	28	Male	Right and left cervical buboes. Very serious case.	1st day	18.9.97	21.9.97	60 c c. i 3n doses -	4 days.	·
28	55	Female	Axillary bubo. Very serious case, with extreme heart weakness.	4th or 5th day.	19.9.97	19.9.97	30 c.c. a few hours before death.	4 or 5 days.	—
29	44	„	Small, painless, left inguinal bubo. Case of slight severity.	3rd day	21.9.97	—	40 c.c. in 2 doses -	—	22.10.97
30	40	„	Right inguinal bubo. Case of average severity.	2nd day	22.9.97	30.9.97	40 c.c.	10 days.	—
31	32	„	Left axillary bubo. Mild case.	2nd day	23.9.97	—	10 c.c. injected without necessity, at patient's request.	—	24 9.97
32	14	Male	Right inguinal bubo. Coma. Very serious case.	3rd day	24.9.97	24·9.97	30 c.c. a few hours before death.	3 days.	—

Dr. Simond's summary of his results at Karad and elsewhere, up to February 1898.

540. At this point, before we pass to consider the observations which were made at Karachi in May and June 1898, it will be convenient briefly to consider Dr. Simond's results up to February 1898, the date at which this observer furnished to the Surgeon-General with the Government of Bombay a report which is printed as Appendix VII. of our Proceedings.

I. 349.

From the report in question we learn that, up to the date when it was made, in all some 300 patients had been treated by Dr. Simond. These cases were drawn from Karad, Bombay, Cutch Mandvi, and Mumbra. The case-mortality of these 300 patients is given as 58 per cent. It is contrasted with the mean mortality—75 per cent.—"which I" (the quotation is taken from Dr. Simond's translated report) "registered in the same hospital" (hospitals, we presume is intended) "for the cases not treated with serum." Recognising that this standard of comparison is hardly an appropriate one, Dr. Simond institutes a further comparison between (*a*) "a class of patients treated from the first to the fourth day," and (*b*) 90 patients "at the same time and in the same hospital (sic)—of whom a part were treated at Cutch Mandvi and a part at Bombay." Dr. Simond states that there was a case-mortality of 66 per cent. in the former, that is in the serum-treated cases, as compared with a case-mortality of 82 per cent. in the latter, that is in the untreated cases. A further comparison is instituted between the Musalmans admitted to hospital at Karad and Mumbra on the first and second days of the disease and treated with serum, and control cases admitted on the corresponding days. Lastly, a comparison is made between Hindus admitted and treated with serum on the first two days of their illness with Hindus admitted in the same stages of the disease and untreated.

Loc. cit.

The results of these comparisons are summarised by Dr. Simond in the statement "that the difference in favour of the sero-therapic treatment is not very great, it oscillates round 15 per cent., but that is not a quantity to be despised, if one remembers that no other treatment has produced up to date any result whatsoever." With last commentary we find ourselves in sympathetic agreement. At the same time, seeing that the difference which is claimed in favour of the serum treatment is "not very great," we think that this difference ought, at least, to have been established by more convincing statistical methods.

Observations made by Dr. Simond on serum treatment at Karachi. Appendix XLIII. in Vol. II. of these Proceedings.

541. We pass from this to the consideration of the observations which Dr. Simond made in Karachi in May and June 1898. With regard to the results of the serum treatment in this City, our sources of information are, on the one hand, a report of Dr. Simond to the Surgeon-General with the Government of Bombay, and, on the other hand, the evidence of Dr. Nazareth, who was in charge of the Seth Vishandas Plague Hospital in Karachi, where the majority of Dr. Simond's patients were treated.

II., 461-3.

We have carefully compared these two sources of information and find that they agree in all essential particulars, though there are a few obvious clerical errors in the records as they have reached us. We learn from Dr. Simond's figures—which may be taken as the basis of our study—that 70 cases—we omit from consideration four cases (the cases numbered 32, 36, 37, 38 in the lists attached to his report) the event of which has been left unrecorded—were treated by Yersin's serum in Karachi. Most of these cases were treated in the Seth Vishandas Hospital.

System on which patients were selected for treatment.

13,280.

The patients were, as Dr. Nazareth informed us, taken for serum treatment "purely on the fact of their being recent." If we go by the record furnished, it would appear that the preponderating majority of the patients treated had only arrived at the second day of the disease. Only three patients are recorded as having reached the fifth day of the disease at the time when the treatment was inaugurated.

Types of the disease in the patients treated with serum.

Of the cases tabulated by Dr. Simond, 51 were cases of uncomplicated bubonic plague, 9 others were cases of bubonic plague complicated with secondary pneumonic symptoms, 7 being cases of primary pneumonia, and the remaining 3 being apparently cases of septicæmic plague. Many of the cases treated were, when the treatment commenced, in a very grave condition, not a few being comatose, and some already at the point of death.

Statistics regarding the effect of serum treatment in Karachi.

542. The general results obtained are set forth in the following table:—

Cases.	Deaths.	Case-Mortality.
70	37	53 per cent.

The case-mortality of these patients is not compared by Dr. Simond with the case-mortality of any series of controls. When the fact is taken into consideration that a large number of pneumonic cases were included in the group, and that all convalescent patients were excluded, it would seem reasonable to conclude that the mortality was below the average of that usually met with in plague.

With a view to obtaining more definite data upon which to base a conclusion with regard to the effect of the serum cases we obtained from Dr. Nazareth, on the one hand, the figures which set forth the comparative case-mortality for the treated and untreated patients in the Seth Vishandas Hospital, and, on the other hand, the gross case-mortality for this hospital during the period of serum treatment, and in the periods which preceded and followed the period in question. Both sets of figures have been incorporated in the following table:—

13,272-9.

Period anterior to Adoption of Serum Treatment (*from beginning of the Epidemic to the 9th of May 1898*).			Period of Serum Treatment (*from the 9th of May to the 6th of June 1898*).				Period subsequent to Discontinuation of Serum Treatment (*from the 6th of June 1898 to the end of the Epidemic*).		
Cases.	Deaths.	Case-Mortality.	——	Cases.	Deaths.	Case-Mortality.	Cases.	Deaths.	Case-Mortality.
—	—	—	Ordinary treatment - -	74	55	74 °/o	—	—	—
—	—	—	Serum treatment - -	47	22	47 °/o	—	—	—
288	202	70 °/o		121	77	63 °/o	38	21	55 °/o

Consideration of the above statistics.

Taking first the figures referring to the gross mortality in the hospital, we notice that the case-mortality declined considerably in the period of serum treatment as compared with the period before the serum treatment. Moreover, this downward movement in case-mortality continued in the subsequent period when the serum was no longer available. The general decline in the case-mortality must, therefore, have been due to an alteration in the type of the disease, and, indeed (as will be seen on reference to the curve of the epidemic in Karachi in the chart printed in paragraph 329 of this Report), the epidemic was very rapidly declining in the latter half of May and the beginning of June 1898.

Turning now to the other aspect of the table, it will be seen on consideration of the figures relating to the comparison between the case-mortality of the serum cases with that of the residuum of cases, that the former compares very favourably with the latter. In the absence, however, of detailed information, we cannot arrive at a conclusion as to whether the average severity of the residuum of cases treated in the hospital can be taken as comparable to the average severity of the serum cases. While the fact that all the convalescent cases were included in the residuum of cases would seem to suggest that the serum cases were cases of greater average severity than the residuum of cases, the fact that the mortality of the residuum of cases during the serum period is somewhat higher than the case-mortality of the previous period, and the fact that it was disproportionately higher than the case-mortality of the succeeding period, would seem to suggest that the residuum of cases may have included a large number of moribund or hopeless cases. We are thus, as has been said before, precluded from forming a definite conclusion as to the effect exerted by the serum on the case-mortality.

Effect of serum treatment at Karachi according to the date of the disease on which it was commenced.
I. 460.

543. Having been frustrated in this direction, we may turn and employ the only other statistical methods still open to us with a view to gauging the efficacy of the serum. In other words, we may compare, as has been done by Dr. Simond, the serum cases among themselves with a view to determining whether the case-mortality was reduced among those treated early as compared with those treated late. The results of this comparison are set forth in the following table:—

—	1st Day.		2nd Day.		3rd Day.		4th Day.		5th Day.		6th Day.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Number of cases and deaths	9	4	28	14	19	8	10	8	3	2	1	1
Case-Mortality - -	1 in 2·2		1 in 2		1 in 2·4		1 in 1·2		1 in 1·5		1 in 1	

In this list there are, however, included five cases who were almost in articulo mortis when they received the serum besides 10 cases of septicæmic and primary pneumonic plague, who all died. If we eliminate these, as we perhaps should, the case-mortality of the patients treated on sucessive days reads as follows:—

—	1st Day.		2nd Day.		3rd Day.		4th Day.		5th Day.		6th Day.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
	6	1	23	9	16	5	6	4	3	2	1	1
Case-Mortality - -	1 in 6		1 in 2·5		1 in 3·2		1 in 1·5		1 in 1·5		1 in 1	

The comparison is even more favourable than the comparison set forth in the previous table to Dr. Simond's contention that the serum was more effective when administered in the early stages of the disease than when administered in the later stages. We cannot, however, overlook the fact that we were told by Dr. Nazareth that "everyone admitted to hospital stated that they were recently infected. They never admitted that they had been infected more than one day for fear of prosecution by the authorities." 13,287. In view of this statement of Dr. Nazareth, it unfortunately becomes impossible to attribute much importance to the statistical comparison made by Dr. Simond between the case-mortality of patients treated early and of patients treated late with serum.

Effect of serum injection at Karachi on the symptoms of the disease.

544. Having given the statistical results of Dr. Simond's observations at Karachi, we may now pass on to consider the effect of the serum on the various symptoms of the disease.

Effect of serum treatment on temperature.
I. 457-9.

On a study of the temperature records contained in notes furnished to us by Dr. Nazareth, we find that in fatal cases the treatment had not the slightest permanent effect on the temperature. This oscillated during the treatment, almost without exception, between 102° and 104° F. In certain cases, however, the injection of serum

Paragraph 530 in this Chapter.

was followed by a fall of one or two degrees in the temperature. It is noticeable that, as was the case also in our own observations, the fall occurred nearly always at night after the evening injection.

The action of serum on the temperature was not more pronounced in the cases which ended in recovery. In these the temperature, apparently, did not return to the normal any sooner than in many cases treated by ordinary methods. Indeed, a careful examination of the notes of 11 cases of patients who recovered after serum treatment shows no essential difference between these cases and those who had recovered under ordinary methods of treatment.

Effect of serum on pulse and other symptoms. 13,318, 13,319, 13,323.

The pulse, on the other hand, often became less rapid after an injection of serum. The tongue also often became clean and moist. A general improvement in the symptoms also manifested itself in many cases, this not being confined to cases which terminated in recovery.

Effect of serum on septicæmic cases and cases of primary and secondary plague pneumonia.

The serum does not appear to have the slightest influence on septicæmic or pneumonic cases. Almost all of these succumbed. Hardly more successful was the serum treatment in cases of secondary pneumonia. Again, the serum does not appear to prevent the appearance of secondary pneumonia; in some of the cases pneumonia appeared two to four days after the beginning of serum treatment.

Effect of serum treatment on convalesence.

Lastly, convalescence does not appear to have been in any way shortened or affected by the serum treatment. In several cases it is distinctly noticed that it was lingering and slow, and in four cases it was complicated by rheumatic articular pains. Suppuration occurred in several of the bubonic cases that recovered.

V.—(D.) *Observations made by the German Plague Commission.*

Details regarding number of cases treated by the German Plague Commission and the results.

Report of the German Plague Commission, pp. 226–31.

545. The last observations which we have to consider in connexion with the effect of the Yersin's serum as prepared at the Pasteur Institute in Paris, are the observations of the German Plague Commission. We would note that these observations all referred to cases treated with "the older" samples of anti-plague serum received by the German Plague Commission, which tests on animals, as reported in a previous paragraph of this Chapter, had shown to be much less efficacious than the later samples of serum received by the Commission. The observations in question relate to 26 cases of plague—we are not told upon what principle these cases were selected—which were treated with the serum in the Bombay hospitals. Of the 26 cases, 13 died and 13 recovered. These results are not compared by the German Plague Commission with those of any parallel series of controls, but we would note that the case-mortality is below the average usually met with in plague.

Comparison between cases treated early and late by the German Plague Commission.

The comparison between the cases treated early with serum and those treated late is that shown in the following table :—

——	1st Day.		2nd Day.		3rd Day.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
	11	6	9	5	6	2
Case-Mortality - - -	1 in 1·8		1 in 1·8		1 in 3	

Conclusions arrived at by the German Plague Commission.

Loc. cit.

546. The conclusion which is arrived at by the German Plague Commission, by comparing the course and character of plague in the serum cases with that in cases not thus treated is summed up by them in the statement that "the only certain inference which can be drawn is that the injections of serum have had no perceptible immediate or remote harmful results. One finds," write the Commissioners, "that the character and duration of the course of the disease and the character and the duration of the convalescence varies within the widest limits in the case of those treated with serum. The duration of convalescence, as judged by the stay in hospital, in the case of patients treated with serum, averaged between seven and 51 days, with an average of 26 days, and is not materially different from the duration which we have calculated in 90 patients who were admitted to the Parel Hospital on the first and second day of the disease, and who recovered without treatment with serum. In them the limits were three to 110 days, the stay of the patients in the hospital averaging 20½ days."

V.—(E.) *Preventive Inoculation with Yersin's Serum.*

547. So far we have dealt with the results obtained by the administration of Yersin's serum to persons actually suffering from plague. The inoculation of this serum has been recommended also as a preventive measure in the case of healthy persons who are likely to come in contact with plague, though it is not claimed that it is likely to afford protection for more than 10 days. Preventive inoculation with Yersin's serum.

It was thus employed in Cutch Mandvi, where one thousand and forty-four persons of all ages were inoculated with 10 c.c. of the serum as a prophylactic during the epidemic of plague and of these five are known to have contracted plague and two died. In the two cases which were fatal the disease appeared 12 days after inoculation, in two of the other cases the disease appeared 32 days after inoculation, and in the remaining case it appeared 45 days after inoculation. Injection of serum as a preventive. 27,130.

A similar application of the serum was made by Dr. Simond in the places where he used the serum for curative purposes. In the report, from which we have already quoted in a previous section, Dr. Simond records that he had up to February 1898 used the serum as a prophylactic in the case of 1,160 persons. It was found impracticable to follow up the subsequent history of all these patients and to determine whether they were afterwards brought into contact with infection and successfully resisted it. Dr. Simond had, however, heard of nine of his patients who contracted plague, the first of them contracting it 14 days after inoculation with the serum. He reports that the case-mortality in these attacks was not in any way reduced. Captain Smith, I.M.S., has supplied us with certain further information with regard to the subsequent history of Dr. Simond's patients at Karad and Masur. Twenty-nine out of the inoculated persons, whose number is not accurately known, were known to Captain Smith as having been afterwards attacked by plague. The following table gives particulars with regard to the event of the disease and the date after inoculation at which 21 of these patients were attacked :— App. VII., I., 349-50. III. 137.

1	patient was	attacked	with	plague	6 days	after inoculation	and died.
1	,,	,,	,,	,,	12 ,,	,,	,,
2	patients were	,,	,,	,,	16 ,,	,,	,,
7	,,	,,	,,	from	20 to 30 ,,	,,	6 died.
7	,,	,,	,,	,,	30 to 40 ,,	,,	all died.
1	patient was	,,	,,	plague	40 ,,	,,	and died.
1	,,	,,	,,	,,	53 ,,	,,	,,
1	,,	,,	,,	,,	70 ,,	,,	,,

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With regard to the effects produced by the serum Dr. Simond makes the following note :—" In 21 cases I have noticed transient symptoms, such as fever, pain in the joints, and swelling of glands. I have been able to satisfy myself that these symptoms, which have been of short duration, and have never obliged the persons vaccinated to remain in bed, arise from the fact that the horse which had furnished the serum had been bled too soon after an injection of virus, at a time that his blood still had feebly toxic properties." Vol I., p. 350.

V.—(F.) *Observations of the Russian Plague Commission on the Effect of the Administration of an Anti-Plague Serum prepared in St. Petersburg.*

548. We pass now from the consideration of the results obtained by the administration of Yersin's serum as prepared at the Pasteur Institute, Paris, to consider a series of systematic observations made by the Russian Plague Commission in March and April 1897, with a view to determining the therapeutic effect of serum that was prepared in the Imperial Institute of Preventive Medicine, St. Petersburg, on similar lines to those followed in Paris. The results of the Russian observers have already been placed on record in both Russian and English Medical Journals and evidence regarding them was given before us by Dr. Clemow and Captain Jennings, I.M.S. Observations by the Russian Plague Commission on serum prepared in St. Petersburg. App. XXII., I., 497-511. 7222-32. 1322-33

549. The cases on which the utility of the serum treatment was tested were not in any way selected. Every alternate patient who was admitted during the period of observation into the Parel Hospital, Bombay, was treated with serum, the treatment being Selection of cases and mode of administration of serum.

withheld only when the diagnosis of plague was uncertain or when the patient was actually on the point of death. The series of observations embraced 50 patients treated with serum and the 50 alternate patients who served as controls. "At first," as we learn from Captain Jennings, I.M.S., "the quantity of serum injected was 20 c.c. daily in one dose. Later on 10 c.c. were injected in the evening as a second dose, and still later the morning dose was increased to 30 c.c. These doses, not having any effect, they were further increased to 40 c.c. in the morning and 20 c.c. at night. More than half the cases were treated with the latter doses." 1323.

Consideration of cases treated by the Russian Plague Commission.

Results of serum injection on case-mortality.

7224.

550. The following table synopsises the results of treatment, and affords a comparison between cases treated with serum and cases which received only ordinary treatment, the figures being furnished to us by Dr. Clemow, who has supplied us with detailed notes regarding each of the serum cases:—

—	Cases.	Deaths.	Case-Mortality.
Serum treatment -	50	40	80 per cent.
Ordinary treatment - -	50	40	80 per cent.

It will be seen that the serum had no effect whatever on the case-mortality.

Effects of serum injection according to the date of the disease when injection commenced.

A comparison may also be instituted between the cases admitted and treated with serum in the early stage of plague with the cases admitted and treated with serum in the later stage of the disease. The comparison in question—we omit from consideration three cases whose history could not be ascertained—is as follows:—

—	1st Day.		2nd Day.		3rd Day.		4th Day.		5th Day.		After 5th Day, and undetermined.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
	6	5	19	15	5	4	6	5	5	5	9	6
Case-Mortality - -	1 in 1·2		1 in 1·3		1 in 1·2		1 in 1·2		1 in 1		1 in 1·5	

It will be seen that the comparison furnishes no evidence that the serum was more effective when administered early than when administered late.

Effect of serum injection on symptoms.

7231.

With regard to the effect of the serum on the symptoms of the patients treated, the following points may be noticed. In a few instances a fall of temperature followed the injections; such falls of temperature are, however, far from uncommon in plague. Dr. Clemow, the Medical Officer in charge of the hospital, was of opinion that they could not be attributed with any degree of certainty to the serum injections. Albuminuria, delirium, nervous symptoms, convulsions, vomiting, hiccough, diarrhœa, and all other symptoms, occurred indifferently in the serum patients and the controls. The serum thus appeared to have no effect upon the ordinary complications of plague. Secondary pneumonia occurred in two cases which had received serum; these ended fatally. A small patch of pneumonia also developed in a third serum patient who recovered. In two cases acute keratitis, passing on to general inflammation of the eye-ball, developed. Erysipelas occurred in two cases. Suppuration appeared to be of slightly more common occurrence in the buboes of the serum cases than in the control cases; the figures, however, being small, very little weight can be attached to them.

Conclusions regarding the value of the serum used by the Russian Plague Commission. 1323-4; 7223.

551. It is impossible, in view of the above, to arrive at any other conclusion with regard to the effect of the serum employed than that which was arrived at by Dr. Jassenski, of the Russian Plague Commission, who conducted the test of the serum, and which was concurred in by Captain Jennings and Dr. Clemow, namely, that the serum was "an absolutely indifferent substance, with no influence either for good or evil, on the course of acute plague."

Abstract of cases treated with serum by the Russian Plague Commission.

552. We subjoin an abstract of Dr. Clemow's notes of the cases treated with the serum.

CASES of PLAGUE treated at the PAREL PLAGUE HOSPITAL, BOMBAY, with ANTI-PLAGUE SERUM prepared in the IMPERIAL INSTITUTE of PREVENTIVE MEDICINE at ST. PETERSBURG.

I. 497-511.

No. of Case.	Sex.	Age.	Nature of Illness.	Day of Disease on which first Injection of Serum was made.	Amount of Serum injected.	Length of Illness, in Days, in Fatal Cases.	Remarks.
I.	Male	21	Bubo in right groin	5th day	100 c.c. in 5 doses of 20 c.c. per diem.	16 days	Admitted to hospital on the 3rd day of illness, but not treated with serum till 2 days after.
II.	Male	22	Bubo in right groin, and bronchitis.	2nd day	160 c.c. in doses of 20 c.c. per diem.	—	Recovered. The temperature did not come down till the 10th day of the disease. The bubo had to be incised.
III.	Male	21	Bubo in left femoral region.	15 hours after onset.	40 c.c. in 2 doses of 20 c.c. per diem.	Less after 4 days after onset of symptoms.	The patient was, apparently, a mild case at the beginning.
IV.	Female	65	No bubo at first; left femoral bubo appeared on day after injection of serum.	2nd day	40 c.c. in 2 doses of 20 c.c. per diem.	4 days	
V.	Male	30	Right inguinal bubo	5th day	60 c.c. in doses of 20 c.c. per diem.	8 days	
VI.	Male	25	Bubo in right axilla, and bronchitis.	?	60 c.c. in doses of 20 c.c. per diem.	?	The patient died 52 hours after the commencement of serum treatment.
VII.	Male	32	Bubo in inguinal region	2nd day	90 c.c. in doses of 30 c.c. on the 3rd day of treatment, and 20 c.c. per diem on the other days.	7 days	
VIII.	Male	19	Right femoral bubo	2nd day	290 c.c. (*See* Remarks.)	—	Recovered. Patient's illness lasted 15 days. He had 50 c.c. in 2 doses of 30 c.c. and 20 c.c. on the 2nd day of illness. The bubo nevertheless increased, and 30 c.c., were injected on the 4th day. 20 c.c. on the 5th day, 30 c.c. on the 6th day, 20 c.c. on the 7th day, and 40 c.c. on the 8th day. The bubo had to be incised. An urticurial rash appeared on the 8th day, and disappeared on the 9th.
IX.	Female	12	Right inguinal bubo	6th day	20 c.c. in 1 dose 35 minutes before death.	6 days	
X.	Male	22	Left inguinal bubo	2nd day	80 c.c. in doses of 30 c.c. and 20 c.c. on the 1st day of treatment, and of 30 c.c. on the 2nd day.	3 days	
XI.	Male	9	Left axillary bubo	20 hours after onset.	50 c.c. in doses of 20 c.c. and 10 c.c. on the 1st day of treatment, and of 20 c.c. on the 2nd day.	2 days	
XII.	Male	25	Bubo in right groin and right side of neck.	2nd day	80 c.c. in doses of 30 c.c. on the 1st day of treatment, and of 20 c.c. and 30 c.c. on the 2nd day.	4 days	
XIII.	Male	23	Admitted with left axillary bubo; on the 7th day of illness a bubo appeared in the left groin.	2nd day	340 c.c. in doses of 30 c.c. and 20 c.c. on the 1st day of treatment, 20 c.c. on the 2nd day, 30 c.c. on each of the 3rd, 4th, and 5th days, 40 c.c. on each of the 6th, 7th, 8th, and 9th days, and 20 c.c on the 10th day of treatment.	11 days	
XIV.	Female	19	Bubo in left groin	2nd day	150 c.c. in doses of 30 c.c. on the 1st day of treatment, 60 c.c. (in equal doses) on the 2nd day, and 20 c.c. on each of the 3 succeeding days of treatment.	7 days.	
XV.	Female	35	Bubo in left groin	4th day	60 c.c. in one dose of 30 c.c. on the 1st day of treatment, and doses of 20 c.c. and 10 c.c. on the 2nd day.	6 days	Had been confined four months beforehand.
XVI.	Female	12	Bubo in right groin	1st day	30 c.c. in one dose	2 days	
XVII.	Female	20	Left cervical bubo	7th day	110 c.c. in doses of 30 c.c. and 20 c.c. on the 1st day of treatment, and of 30 c.c. on each of the next 2 days.	10 days.	
XVIII.	Female	30	Right cervical bubo, with lung symptoms.	15th day after appearance of bubo, and 4th day after onset of fever.	60 c.c. in doses of 30 c.c. per diem.	5 days after onset of fever.	
XIX.	Female	9	Right femoral bubo	2nd day	60 c.c. in doses of 20 c.c. per diem.	—	Recovered. The bubo had to be opened.
XX.	Male	40	Bubo in left groin	2nd day	90 c.c. in doses of 30 c.c. and 20 c.c. on the 1st day, and of 40 c.c. on the 2nd day of treatment.	3 days.	
XXI.	Male	13	Bubo in left groin	2nd day	30 c.c. in one dose	2 days.	

No. of Case.	Sex.	Age.	Nature of Illness.	Day of Disease on which first Injection of Serum was made.	Amount of Serum injected.	Length of Illness in Days, in Fatal Cases.	Remarks.
XXII.	Male	45	Left inguinal bubo. A bubo appeared in the right groin about a fortnight after serum treatment commenced.	4th day	160 c.c. in doses of 30 c.c. and 20 c.c. on the 1st day of treatment, 30 c.c. on the 2nd day, and 40 c.c. on each of the next two days.	—	Recovered. Patient was over 40 days in hospital. The bubo did not suppurate.
XXIII.	Male	20	Left inguinal bubo	1st day	340 c.c. in doses of 40 c.c. on each of the first 8 days of treatment except the 5th, when no injection was made, and of 20 c.c. on the 9th, and of 40 c.c. on the 11th day of treatment.	—	Recovered. The bubo suppurated. Patient was nearly two months in hospital.
XXIV.	Male	25	Right femoral bubo	2nd day	80 c.c. in two doses of 40 c.c. per diem.	4 days.	
XXV.	Male	14	Right femoral bubo and lung symptoms.	8th day	200 c.c. in doses of 40 c.c. and 20 c.c. on the 1st day of treatment, of 40 c.c. on each of the 2nd, 3rd and 5th days, and of 20 c.c. on the 8th day of treatment.	—	Recovered. Patient was nearly two months in hospital. The bubo was opened.
XXVI.	Male	30	Bubo in left groin	4th day	220 c.c. in doses of 40 c.c. on each of the first 5 days of treatment and of 20 c.c. on the 6th day.	13 days.	
XXVII.	Male	25	Right nguinal bubo	4th day	40 c.c. in one dose	5 days.	
XXVIII.	Male	25	Bubo in left groin	2nd day	80 cc. in two doses of 40 c.c. per diem.	3 days.	
XXIX.	Male	16	Left inguinal bubo	?	120 c.c. in doses of 40 c.c. and 20 c.c. on each of the days of treatment.	?	Patient died on the 2nd day after beginning of the serum treatment. He had been inoculated five days before death with Haffkine's prophylactic fluid.
XXX.	Male	27	Right axillary bubo	ay	140 c.c. in doses of 40 c.c. and 20 c.c. on each of the first 2 days and of 20 c.c. on the 3rd day of treatment.	—	Recovered. Patient had a severe accident while in hospital. He left hospital 23 days after entering it.
XXXI.	Male	25	Bubo in left groin	3rd day	60 c.c. in doses of 40 c.c. and 20 c.c. on the 1st day of treatment.	4 days	
XXXII.	Male	19	Bubo in right groin	3rd day	180 c.c. in doses, on each of the 3 days of treatment, of 40 c.c. and 20 c.c.	6 days	
XXXIII.	Male	67	Bubo in right groin	2nd day	250 c.c. in doses of 30 c.c. and 20 c.c. on each of the first 3 days of treatment, of 40 c.c. and 20 c.c. on the 4th day, and of 40 c.c on the 5th day.	8 days	
XXXIV.	Male	23	No bubo, sibilant rhonchi.	4th day	100 c.c. in doses of 40 c.c. and 20 c.c. on the 1st day, and of 40 c.c. on the 2nd day of treatment.	6 days	
XXXV.	Male	50	Enlargement of left supratrochlear gland and swelling of upper arm.	3rd day	100 c.c. in doses of 40 c.c. on the 1st day, and of 40 c.c. and 20 c.c. on the 2nd day of treatment.	6 days	
XXXVI.	Male	35	Left femoral bubo	2nd day	140 c.c. in doses of 40 c.c. and 20 c.c. on the 1st day, and of 40 c.c. on each of the next 2 days of treatment.	—	Recovered. Patient was fit for discharge 6 weeks after his admission to hospital.
XXXVII.	Male	22	Bubo in left groin	5th day	100 c.c. in doses of 40 c.c. on the 1st day, and of 40 c.c. and 20 c.c. on the 2nd day of treatment.	7 days	
XXXVIII.	Female	7½	Right cervical bubo	9th day	20 c.c. in two doses of 5 c.c. on each of the 1st and 2nd days of treatment.	—	Recovered. The bubo suppurated. Patient was 33 days in hospital.
XXXIX.	Male	25	Bubo in right groin	2nd day	100 c.c. in doses of 40 c.c. and 20 c.c. on the 1st, and of 40 c.c. on the 2nd day of treatment.	3 days	
XL.	Male	22	Right femoral bubo	6th day	240 c.c. in doses of 40 c.c. and 20 c.c. on each of the first 4 days of treatment.	—	Recovered. Patient was 36 days in hospital.
XLI.	Male	12	Lung symptoms on admission but no bubo; a left axillary bubo appeared the day after treatment commenced.	1st day	60 c.c. in doses of 20 c.c. on the first day, of 20 c.c. and 10 c.c. on the 2nd day, and of 10 cc. on the 3rd day of treatment.	3 days	
XLII.	Male		Bubo in left groin	2nd day	40 c.c. in one dose of 40 c.c. 3½ hours before death.	2 days	
XLIII.	Male		Bubo in right groin	3rd day	120 c.c. in doses of 40 c.c. and 20 c.c. on each of the days of treatment.	6 days	
XLIV.	Male		Bubo in left groin	1st day	60 c.c. in doses of 40 c.c. and 20 c.c. on the day of admission to hospital.	4 days	
XLV.	Male	28	Right femoral bubo	5th day	300 c.c. in doses of 40 c.c. and 20 c.c. on each of the 5 days of treatment.	10 days	
XLVI.	Male	23	Right femoral bubo	5th day	120 c.c. in doses of 40 c.c. and 20 c.c. on each of the 2 days of treatment.	7 days	

No. of Case.	Sex.	Age.	Nature of Illness.	Day of Disease on which first Injection of Serum was made.	Amount of Serum injected.	Length of Illness, in Days, in Fatal Cases.	Remarks.
XLVII.	Male	33	Left femoral bubo	2nd day	60 c.c. in doses of 40 c.c. and 20 c.c. on day of admission to hospital.	2 days	
XLVIII.	Female	25	No bubo at time of admission; a bubo appeared the day after admission.	?	100 c.c. in doses of 40 c.c. and 20 c.c. on the 1st day, and of 40 c.c. on the 2nd day of treatment.	?	Patient died two days after treatment commenced.
XLIX.	Male	22	Bubo in left groin	4th day	120 c.c. in doses of 40 c.c. and 20 c.c. on each of the 1st and 2nd days of treatment.	6 days	
L.	Male	40	Bubo in right groin	2nd day	160 c.c. in doses of 40 c.c. and 20 c.c. on the 1st and 2nd, and of 40 c.c. on the 3rd day of treatment.	6 days	

V.—(G.) *Observations made by Mr. Haffkine on the Effect of an Anti-Plague Serum prepared by himself.*

Observations by Mr. Haffkine on the effects of serum prepared by himself.

553. Mr. Haffkine made several series of experiments to test the utility of anti-plague sera prepared by him by the inoculation of plague cultures into various animals. His first experiments were made upon six patients in the Byculla Jail, Bombay. At his request, the cases which seemed to be most hopeless were placed at his disposal for the trial of the serum. Of the six patients inoculated with the serum, three died. 133–141.

Mr. Haffkine's next experiments were done under somewhat similar conditions. He chose for inoculation with his serum the gravest cases which came under observation in the Arthur Road Hospital, Bombay. "I visited," said Mr. Haffkine, "the Arthur Road Hospital . . . and left it to the Medical Officer in charge to point me out those cases which, in his opinion, were hopeless, that is, those which he thought could not recover without the assistance of some new additional treatment. He told me, for instance, at once that he had a patient who the day before had a temperature of 107°, and that up to that time not a single patient had passed through the hospital who who recovered after having had that temperature. In the same manner he pointed me out a certain number of other patients who, in his opinion, had no chance of recovery under the ordinary treatment. I reasoned that if a proportion of such patients recovered under the specific treatment, I would have an indication that the serum treatment produced a greater effect than the ordinary treatment adopted in the hospital. Very soon I had to abandon that method, as no such indication was obtained." 140.

With a view to more completely testing the possibilities of the serum treatment, and with a view to testing it on a series of cases of average severity, Mr. Haffkine, working in collaboration with Major Bannerman, I.M.S., made a series of systematic observations on a large number of plague patients admitted to hospital in Poona. Every alternate patient was taken for serum treatment, the intermediate cases serving as controls. Mr. Haffkine describes the results he observed as follows. 140. "With the exception of those who died within one hour, or a few hours, that is, before we could see them, we treated with plague anti-toxic serum every second patient admitted during the hours we were at the hospital, irrespective of the information as to the serious or promising condition of the patient or the duration of the disease before admission. . . . After a couple of hundred patients had passed through our hands, we compared the mortality statistics among the treated and among the non-treated. I expect it was an accident, but the mortality amongst the treated was higher than among the non-treated. The moment that became clear we suspended further treatment."

"Further attempts," said Mr. Haffkine, "were made in Bombay, but exceedingly cautiously, with some homœopathic doses, injecting 1 to 5 c.c. of the serum or so. . . . We varied the treatment in many ways. For instance, a patient would receive only 1 c.c. or he would receive that amount repeated every five hours; or, again, he would receive a dose of 10 c.c. once in two days. The patients were always observed comparatively with others admitted at the same time. In no case did we observe a noticeable advantage on the side of the patients treated." 141.

The serum prepared by Mr. Haffkine had evidently no beneficial effect. Conclusion.

VI.—The Results obtained by the Inoculation of Lustig's Serum.

VI.—(1.) *General Account of Observations made in the Arthur Road Hospital, Bombay.*

Observations of the effect of treatment with Lustig's serum.

Para. 514 of this Report.

554. We now pass to the results of the therapeutic administration of Lustig's anti-plague serum to human patients. As already explained above, we did not ourselves test the effects of Lustig's anti-plague serum upon human plague patients, inasmuch as we were satisfied that the animals which were treated with the particular sample of serum with which we were furnished succumbed to plague more readily than untreated animals. The results of the treatment with Lustig's serum which was undertaken at the Arthur Road Hospital in Bombay by Dr. Choksy may, however, be considered.

Observations made by Dr. Choksy in the Arthur Road Hospital, Bombay.

555. Dr. Choksy's observations fall naturally into three series. One of these series of observations had already been completed when we arrived in India. The results of this series of observations, which covered the period from March to October 1898, were communicated to us by Dr. Choksy when he came before us. The second series of observations was in progress during the latter part of our stay in Bombay, and we had the advantage of seeing certain of the patients. This series of observations covered the period from February to April 1899. Lastly, the third series of observations was commenced in May 1899. We have learned of the results of these from the communications made by Dr. Choksy and Dr. Mayr to the "Bombay Medical and Physical Society" in September 1900, and the "Bombay Medical Union" on the 21st of April 1900, respectively. Reprints of these communications were kindly furnished to us by the authors.

We propose to deal seriatim with the three series of observations particularised above.

VI.—(2.) *First Series of Observations in the Arthur Road Hospital, Bombay.*

First series of observations made by Dr. Choksy in March to October 1898. 20,952.

556. In the first series of observations, 257 cases of plague were treated with the serum, all at the Arthur Road Hospital. The serum which was employed was prepared under Professor Lustig's direction in Italy. The serum was usually administered night and morning, and it was employed in doses of from 10 to 30 c.c.; these were also the doses employed in the case of the sera made in Bombay and used in subsequent series of observations.

Principle upon which the serum cases and controls were selected, and statistics of results. 20,945–50.

The patients to whom the serum was therapeutically administered were to some extent selected, all moribund patients being excluded, except in March and part of the month of April. The case-mortality of the selected patients who were submitted to the serum treatment was compared with the case-mortality in the remainder of the hospital patients, including, as this did, the moribund patients who were excluded from the serum group. The results as set forth by Dr. Choksy were as follows:—

20,952.

—	Cases.	Deaths.	Case-Mortality.
Ordinary treatment - -	752	595	79·1 per cent.
Serum treatment - -	257	145	56·4 per cent.
Difference in favour of the serum cases - - -			22·7 per cent.

Critical consideration of these results.

557. Before accepting these results as proof of a benefit accruing from the serum treatment, we must go somewhat more closely into the question of the comparability of the two contrasted groups of cases. The selected cases to whom the treatment was applied included, as Dr. Choksy told us, 30 moribund patients. We may presume that a proportionate number of convalescent patients was also included. We shall see in the next paragraph that for every 30 moribund patients admitted to the Arthur Road Hospital 7 convalescent patients were on the average admitted. Thus, during the period in which selection was applied and in which the 30 moribund patients referred to above were included in the serum group, there would in all probability have been 7 convalescent

patients included in that group. This would leave in the serum group a balance of 220 patients admitted in the acute stage of the disease and in a non-moribund condition. Now, it is obvious that during the latter period when the process of selection described by Dr. Choksy was in force an unduly large proportion of moribund and convalescent cases must have fallen to the group of those cases which were not treated with serum. Therefore, no value will attach to the comparison set forth in the table, unless we can apply such corrections to the figures as to ensure that the number of convalescent and moribund patients included in the respective groups of control and serum patients, shall stand in each case in the same proportion to the number of patients in each group admitted in the acute stages and in a non-moribund condition.

Corrections which appear applicable to Dr. Choksy's figures.
III. 457(A).

558. Data for making a rough estimate of the kind here required are incidentally supplied in Appendix LXI. of our Proceedings, and in Dr. Choksy's communication to the Bombay Medical and Physical Society, already referred to above. We find that in 1898, close on 30 per cent. of the patients admitted to the Arthur Road Hospital died within 24 hours of admission. These would come under Dr. Choksy's definition of moribund patients. Further, we find from the analysis of nearly 1,000 hospital cases, given by Dr. Choksy in the communication referred to, that 7 per cent. of patients were admitted to hospital in a convalescent or semi-convalescent condition. To every 63 patients admitted in the acute stages of the disease and in a non-moribund condition, there would thus fall 30 moribund patients and 7 convalescent patients.

Calculating on the basis of these data, there would, in the absence of a system of selection, have fallen to the serum group—consisting, as it did, of 220 patients in the acute stages of the disease and in a non-moribund condition—105 moribund cases in lieu of the 30 actually included, and 24 convalescent cases in lieu of 7, the estimated number of such cases included.

If we make the adjustments which are indicated by these considerations; if, in other words, we transfer cases and deaths from the control group to the serum group, so as to establish a proportionate number of convalescent and moribund cases and deaths in each group; we arrive at the following results:—*

——	Cases.	Deaths.	Case-Mortality.
Control Group -	660	520	79 per cent.
Serum Group - -	349	220	63 per cent.
Difference in favour of the serum group			16 per cent.

Comparability of patients in serum and control groups.

559. A redistribution of the moribund and convalescent patients having been effected in the manner and with the results indicated above, the further question arises as to whether patients in each group who are classed as patients in the acute stage of the disease and in a non-moribund condition were comparable with each other from the point of view of the severity of their cases. We are not satisfied that they were. Rather, we think that when the desire to test the serum only on cases that seemed capable of benefiting from the treatment, and in particular upon patients who seemed likely to live more than 24 hours after admission, came to be a factor in the selection of cases for serum treatment, an influence was introduced which must, no doubt unconsciously, have operated in the direction of including within the serum group the milder, to the exclusion of the severer, cases of plague.

Conclusion regarding first series of observations.

560. In view of this consideration, we are of opinion that the statistics adduced by Dr. Choksy—even after they have been corrected as set forth above—do not afford any conclusive evidence of the efficacy of Lustig's serum.

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* The arithmetical processes by which the figures in this table are arrived at are as follows. We add to the serum group, in addition to the 30 moribund patients already included, 75 in order to make the full number of 105 moribund patients which should have fallen to that group if no selection had been applied. In the same way, to the 7 convalescent cases, which we have assumed to be included in the serum group, we add 17 additional convalescent cases. We thus add 92 cases to the serum group and the same number of cases must naturally be subtracted from the control group. In readjusting the figures relating to deaths, we have to add to the number of deaths already debited to the serum group 75 deaths on account of the moribund patients added to the group, and the same number of deaths has of course to be subtracted from the number of deaths debited to the control group.

VI.—(3). *Second Series of Observations made in the Arthur Road Hospital, Bombay.*

Second series of observations made by Dr. Choksy from February to April 1899.

561. We pass to the second series of comparative observations conducted by Dr. Choksy. As before mentioned, the observations in question cover the period from February to April 1899. The serum employed in this series of observations was prepared in Bombay, under the auspices of the Municipality, by Dr. Galeotti, working under Professor Lustig's instructions. In this series of observations only patients admitted in the acute stages of the disease and in a non-moribund condition were treated with the serum. The residuum of patients admitted to the hospital during the corresponding period was, as in the series of observations that have just been considered, taken as controls.

The results of the second series of observations are set forth by Dr. Choksy in his communication to the Bombay Medical and Physical Society as follows:—

——	Cases.	Deaths.	Case-Mortality.
Control Group - - -	1,190	957	80·5 per cent.
Serum Group - -	403	249	61·8 per cent.
Difference in favour of the serum cases -			18·7 per cent.

Dr. Mayr's argument in support of the method of selection adopted in Dr. Choksy's observations. Communication to Bombay Medical Union.

562. Dr. A. Mayr, who is at present entrusted with the preparation of Lustig's serum, has endeavoured to vindicate the principle of selection adopted by Dr. Choksy, and in particular to establish that the system of selection employed did not result in a selection of the milder type of cases for treatment with the serum.

With this object Dr. Mayr contends, in the first place, that the "exclusion of moribund patients was irrelevant, their place being taken not by mild cases, but by such as would have died later on under the ordinary treatment." This particular argument is obviously fallacious, inasmuch as the exclusion from the serum cases of a group of patients whose mortality is *ex hypothesi* 100 per cent., is not counterbalanced by the inclusion among the serum cases of a group of patients whose mortality works out, after the moribund patients have been deducted, as between 64 and 65 per cent.

Dr. Mayr's second argument is more subtle. He contends that the fact that the case-mortality in the cases in the Arthur Road Hospital not treated with serum was higher only by a fraction than the mortality for the corresponding period in the Mahratta and Modi Khana Hospitals,* where the serum was not used, is a fact which constitutes conclusive proof that the control cases in the Arthur Road Hospital, and in correspondence with these the selected serum cases, represented equally severe types of the disease. Reflection, however, shows that no weight can attach to this argument, inasmuch as only 25 per cent. of the total patients admitted into the Arthur Road Hospital were selected for serum treatment, and hence there was no opportunity afforded for any considerable artificial inflation of the figures representing the case-mortality of the large residuum of cases at the Arthur Road Hospital who were not treated with serum. It will be seen on comparing the figures of the mortality for the cases treated and not treated with serum in the table above, with those given in the table below, that even though the selection of cases for serum treatment may not have brought about any great artificial increase of the recorded case-mortality of the patients not treated with serum, it may quite well have brought about an appreciable artificial reduction in the recorded case-mortality of the serum group.

Corrections which appear applicable to Dr. Choksy's figures.

563. With a view to measuring the effect which was probably produced by the system of selection applied to the serum cases, we may, as in the previous set of statistics, transfer moribund and convalescent patients from the control group, to which they are credited in Dr. Choksy's statistics, to the serum group, in which they would have been classed if each alternate patient had been referred to the serum or control group in accordance with the order in which he was admitted to the hospital. The

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* The case-mortality in the cases not treated with serum in the Arthur Road Hospital was 80·5 per cent. The case-mortality of the total plague cases in the Modi Khana and Mahratta Hospitals was 80·3 per cent.

results which would have been arrived at, if this procedure had been adopted, would (reckoning* here as before) have been as follows :—

——	Cases.	Deaths.	Case Mortality.
Control Group -	953 (1190 as recorded in table above — 227 cases transferred to serum group).	765 (957 — 192)	80 per cent.
Serum Group -	639 (403 as recorded in table above + 192 moribund patients + 45 convalescent patients).	441 (249 + 192)	69 per cent.
Difference in favour of serum group - - - - - -			11 per cent.

After making the adjustments that would seem indicated, there would appear to remain only a comparatively small advantage to the credit of the serum cases. Moreover, against this balance must be set off the fact that the acute cases included in the serum group were, as has been pointed out in the case of the first series of statistics, probably less grave than the corresponding class of cases which is included within the control group. In conformity with this we can hardly accept the result of the second series of observations as conclusive evidence of an advantage accruing from serum treatment.

VI.—(4.) *Third Series of Observations made in the Arthur Road Hospital, Bombay.*

564. We now pass to the consideration of the third series of systematic observations which were made by Dr. Choksy on the effects of Lustig's serum. In this series of observations we learn that no system of selection came into operation. Every patient, when once the diagnosis of plague was clear, was referred, in the order of his admission, in an alternate manner either to the serum or the control group. The whole series consisted of 968 patients, 484 being included in each group. The results of this comparative series of observations were, as, indeed, we have already incidentally seen above in the course of our discussion of the method of selecting controls, as follows :—

Dr. Choksy's third series of observations from May 1899 to August 1900.

——	Cases.	Deaths.	Case-Mortality.
Control Group - -	484	385	79·5 per cent.
Serum Group - - -	484	329	68 per cent.
Difference in favour of the serum group -			11·5 per cent.

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565 We have here at last a result obtained by a method which satisfies the demands formulated in a previous section. The diminution of plague mortality by 11·5 per cent. in such an extensive series of cases treated with the serum seems to us—assuming, as we presume we may do, the correctness of the records—conclusive as to benefit having been derived from the administration of the serum.

Consideration of the statistics relating to the third series of observations.

566. The question as to whether the difference of 11·5 per cent. in the case-mortality which is shown in the above table is to be regarded as the true measure of the advantage accruing from the serum treatment has already been considered above in connexion with the consideration of Dr. Choksy's contention that the record should be amended by the exclusion of the moribund and convalescent patients, and that the result of the serum treatment should be gauged only upon the patients admitted in a non-moribund condition in the acute stages of the disease. We have already expressed our opinion that, even though the full measure of the benefit received does not emerge from the comparison of all the serum cases with all the control cases, the omission of the convalescents and semi-convalescents, and of the moribund patients, from both groups of patients would none the less be inadmissible. We may here restate and somewhat amplify what we have already said on this question.

Question whether these statistics show the full extent of the benefit derived from treatment with Lustig's serum.

Paras. 521-2 in this Chapter.

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* While, as in the case of the previous tables, the adjustments have been calculated out on the basis of 30 moribund and 7 convalescent patients admitted to 63 acute cases admitted in a non-moribund condition, attention is drawn to the fact that it seems possible, in view of an incidental statement in Dr. Mayr's communication to the Bombay Medical Union to the effect that the patients who were selected for serum treatment showed a mortality of 15 per cent. within 24 hours of admission, that the deductions from the control group and the additions to the serum group on account of moribund cases ought to be made on a considerably smaller scale.

Para. 557 in this Chapter.

Restatement of the arguments for rigidly adhering to the "alternate system" in observations.

567. If the statistical principle that patients who are deemed to be moribund on admission should be omitted from the record were accepted, it would, in the first place, never be certain that the clinician, actuated by the fear that the patients had already lapsed into a condition from which recovery was impossible, had not withheld the serum from cases which, though serious, were not beyond therapeutic aid.

Again, if the principle were accepted that every patient who succumbed within a certain period after he had been received into hospital might be classed as a patient admitted in a moribund condition; if, in other words, a proportion of the unsuccessful cases were to be deleted from the record on the assumption that they were, when taken in hand, unsuited for serum treatment; it would be impossible to repose any confidence in the records.

Lastly, it will be manifest to consideration that it would be impossible to define the term "moribund" in any satisfactory way. While some clinicians might restrict the term to those admitted in a pulseless condition, or actually in articulo mortis; others, like Dr. Choksy, would class as moribund all patients who died within 24 to 27 hours after admission; and others, again, might, like Dr. Mayr, be of opinion that all patients who succumb within 48 hours after admission ought to be classed as moribund, *i.e.*, as patients admitted in a condition beyond all possible therapeutic aid. In connexion with the views held on this question by Dr. Choksy and Dr. Mayr, we would point out that in the case of snake bite death would appear to be preventible by the exhibition of anti-venomous serum, even at a time when, under ordinary circumstances, death would have occurred in much less than 24 hours. We, therefore, think that, in the case of plague, patients ought not to be classed as beyond all conceivable therapeutic aid merely on the ground that such patients have not been benefited by the anti-plague sera which have up to the present been available.

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Bombay Medical Union, 21st April 1900.

VI.—(5.) *Subordinate Questions arising in connexion with Lustig's Serum.*

Subordinate questions in connexion with Lustig's serum.

568. Before passing on to summarise the conclusions we have arrived at with regard to the general question of the serum therapathy of plague, and the prospects of improving upon the sera at present available, we may briefly glance at a few subordinate questions which arise in connexion with Lustig's serum.

Longer survival of serum cases discussed.

The first of these relates to the question of the longer survival of the serum patients as compared with the control patients. In connexion with this question we have examined such records as are accessible to us without finding any evidence of a longer period of survival or a more rapid convalescence after treatment with the serum. Dr. Mayr, on the other hand, states that during the period covered by the employment of the serum treatment at the Arthur Road Hospital—he has in view the period from March 1899 onwards—the percentage of deaths occurring within 48 hours after admission, calculated on the total admissions, diminished by 8 per cent. as compared with the percentage of similar deaths during the winter months of 1898-99, when no serum was available. We do not think that any certain inference can be based upon the fact animadverted to by Dr. Mayr, for the number of patients who die shortly after arrival at hospital will obviously depend in large measure upon the clinical type of the disease and upon the policy that is adopted in connexion with the removal of patients to hospital. In connexion with the last, we cannot ignore the fact that directions were issued in Bombay in the early part of 1899 that the practice of removing moribund patients to hospital should be abandoned.

Bombay Medical Union, 21 April 1900.
25,560-2.

Effect of serum treatment according to the stage of the disease in which the treatment is commenced.
Vol. III., App. LXII., p. 462.

Passing to the question of the relative effect of the administration of the serum in the early and late stages of the disease, we may note that Captain Childe, I.M.S., after studying the results of the treatment in the case of 148 patients, gives figures to show that the serum was not more efficacious in the cases treated in the earlier stages of the disease than in the cases treated in the later stages. On the contrary, he found "that the mortality of patients treated on the first day is higher than that of all the patients who underwent the treatment, the respective figures being 73·3 and 69·7 per cent."

VII.—SUMMARY REGARDING THE SERUM THERAPEUTICS OF PLAGUE.

Summary.
Section III. of this Chapter.

569. We have seen in the section of this Chapter in which we deal with the results obtained in India by the experimental administration of Yersin's serum to animals artificially infected with plague that, so far as can be judged from the results in the case of the particular samples which were tested in this manner, Yersin's serum,

as sent out from the Pasteur Institute, Paris, contains therapeutically useful substances in greater or smaller quantity. At the same time we saw that in the case of certain samples of serum,—we refer in particular to the samples of serum which were furnished to us, and to that which was employed on human patients by the German Plague Commission,—the dose of serum required to avert death from a plague-infected animal was so considerable as to make it *à priori* doubtful whether any considerable therapeutic effect could reasonably be expected from the exhibition of these sera to human plague patients.

Section V. of this Chapter.

In a subsequent section, in which we studied the results obtained upon human plague patients by the administration of Yersin's serum, we saw that, except in the series of observations made by ourselves and by the Russian Plague Commission, nothing in the nature of a strict statistical comparison could be made between the case-mortality of cases treated with serum and the case-mortality of cases not treated with serum.

There appeared, however, in the case of the patients treated by Dr. Simond in Karachi and the patients treated by Captain Mason, R.A.M.C., in Cutch, to be clinical evidence sufficient to raise a strong presumption that the course of the disease was favourably influenced by the exhibition of the serum.

In the case of our own experiments, conducted with a serum derived from the Pasteur Institute, Paris, further, in the experiments of the German Plague Commission undertaken with a serum of similar derivation, and lastly, in the case of the observations made by the Russian Plague Commission on the effects of the administration of a serum prepared in St. Petersburg, the patients appear not to have benefited in any way from the treatment. At the same time there was not in any of these three series of observations any indication that the serum had in any way aggravated the disease.

In the case of the observations made by Mr. Haffkine with a serum prepared by himself, there appeared, on the contrary, to be a balance of advantage in favour of the patients who were not treated with serum.

Lastly, to complete our summary of the effects of the administration of Yersin's serum, we may recall the fact that in the case of a quite considerable number of healthy persons inoculated prophylactically with Yersin's serum, such statistical results as were obtained were quite inconclusive on the question as to whether the fleeting protective effect which was expected was actually realised. It was, however, noted that in certain cases toxic phenomena, in the form of "fever, pain in the joints, and swelling of the glands," supervened upon the incorporation of the serum.

Section III. of this Chapter.

Passing now in our recapitulation to the effects of Lustig's serum, we saw, in the section of this Chapter which dealt with the results obtained by the incorporation of Lustig's serum into animals, that the samples of serum with which we were furnished apparently exerted an effect in the direction of diminishing the resistance to plague in the animals experimented upon.

Section VI. of this Chapter.

When we passed to consider the average result obtained by the incorporation of Lustig's serum into plague patients, we saw that, of the three successive series of observations brought forward by Dr. Choksy, the first two gave results which were, owing to the system of selection adopted, inconclusive. In the case, however, of the third series of systematic observations, where all possibility of selection was avoided by subjecting to the serum treatment every second patient who was admitted to the hospital, proof was afforded—always assuming the accuracy of the hospital record which, since we had already left India, did not come before us—evidence of a diminished mortality on the part of the patients who were treated with serum. The diminution which was achieved amounted, as we saw, to a reduction of at least 11 per cent. in the case-mortality of the serum cases as compared with that of the control cases treated under precisely similar circumstances. We did not come across any evidence that any unfavourable influence had been exerted when these sera were therapeutically administered to man. It is to be noted that the samples of serum tested by us were not employed upon men.

Conclusions.

570. To sum up, we think we may, not only in view of the facts summarised above, but also of the unequivocal opinion expressed by Dr. Simond, Captain Mason, R.A.M.C., Dr. Choksy, and Dr. Nazareth, as to an improvement having been witnessed by them in the clinical symptoms of patients treated with serum, conclude that, on the whole, a certain amount of advantage in all probability accrued to the patients, both in the case of those injected with Yersin's serum and of those injected with Lustig's serum. It seems to us, however, not impossible, that in exceptional cases the serum treatment—

and this statement, be it noted, could be made also in connexion with every other treatment which has been adopted—may have done positive harm. We can hardly doubt, in view of the experimental results which we obtained with Lustig's serum, and in view of the toxic symptoms observed by Dr. Simond in the case of healthy persons inoculated with Yersin's serum, that the serum may, especially in cases where it was drawn off prematurely from the inoculated horses, have contained either toxic or anti-bactericidal elements. With a view to preventing such deleterious sera coming into use, it seems us to to be absolutely essential that all sera should, before they are brought into therapeutic application on man, be exhaustively tested upon animals.

571. With regard to the future preparation and therapeutic employment of anti-plague sera in India, we may, perhaps, be permitted to offer the following suggestions:—

(1.) We desire to record our opinion that though the method of serum-therapathy as applied to plague has not been crowned with a therapeutic success in any way comparable to that obtained by the application of the serum method to the treatment of diphtheria, none the less the method of serum therapathy is in plague, as in other infectious diseases, the only method which holds forth a prospect of ultimate success.

(2.) We would suggest that the serum treatment has not as yet been sufficiently successful to make it desirable to extend the treatment, under present conditions, as a general measure, over all the districts affected with plague. Rather, it appears to us, that the imperfections of the present methods of preparation and application should be fully recognised, and that it should be realised that the line of progress lies, not in the direction of applying the sera at present available to the largest number of patients, but in the direction of studying in the case of the animals who furnish the serum the blood changes which are associated with the incorporation of the plague toxins and with the elaboration of antidotal and bactericidal substances. In like manner, we think that the condition of the blood in the human plague patient, and the changes brought about by the administration of the serum, should be carefully studied.

(3.) With regard to the procedure followed in the preparation of the sera, we do not think that the facts, which have come before us, are in any way conclusive as to the superiority of the procedure advocated by Professor Lustig over the procedure ordinarily employed. It is true that in the case of Lustig's serum statistical proof has been afforded of a diminished mortality in the cases treated with serum, while no such statistical proof is forthcoming as to the mortality in plague having been diminished by the use of Yersin's serum. But this does not foreclose the question. On the one hand, the absence of the required statistical demonstration of the diminution of case-mortality by the use of Yersin's serum may, so far as the observations of Dr. Simond and Captain Mason, R.A.M.C., are concerned, have depended upon the employment of faulty statistical methods. Again, quite apart from considerations such as those just referred to, the difference in the result obtained in the case of the two classes of serum, may quite well be attributable to the fact that Lustig's serum was, at least, in the case of the observations which have given a conclusively favourable result, prepared in India, and was thus presumably comparatively fresh serum, while Yersin's serum, at least in the case of the serum which was derived from Paris, was applied only after it had been altered by heating and lapse of time. We, therefore, think that it would be wise not to neglect, in the future preparation of therapeutic sera in India, the simpler methods of preparation employed by Yersin and others.

CHAPTER VI.

MEASURES FOR THE SUPPRESSION OF PLAGUE.

I.—MEASURES ADOPTED IN INDIA.

Plague measures.

572. In addition to the steps taken for the discovery of cases of plague, the measures undertaken in India to suppress the disease were directed towards the isolation in hospital of the sick, the segregation of those who had been in immediate contact with the sick, the removal of the healthy from plague-infected places, inoculation with Mr. Haffkine's prophylactic, and the disinfection of infected houses. The measures taken to prevent the disease from spreading were directed to the supervision of travellers by railway and sea, and occasionally to interference with the movement of people from place to place by road. We have already referred to the value of inoculation as a measure for dealing with the plague. We shall now endeavour to indicate how far the other measures enumerated above have individually contributed to prevent the spread of plague.

II.—METHODS OF OBTAINING INFORMATION REGARDING THE OCCURRENCE OF PLAGUE CASES AND PLAGUE DEATHS.

Importance of early information of sickness.

573. The most important and the most difficult matter in all operations against the plague is to obtain early information regarding the cases that occur. The prompt discovery of an imported case may enable the authorities to prevent a local outbreak. Even where a few indigenous cases have occurred, early information regarding each new case may make it possible to prevent the outbreak from spreading beyond a confined area. What is required is information of each case of plague that occurs, as soon as possible after the patient has been attacked. Information that a person has died of plague may be useful to a certain extent, but is less useful than a prompt report of his having fallen sick, since between the time of his being taken ill and his death the damage which it is desired to prevent may already have been caused.

Rules regarding reports concerning infectious diseases in force before the outbreak of plague.

574. Before the outbreak of plague in 1896 there was no machinery for the discovery of cases of infectious disease generally. There were, indeed, special orders of an executive character which required reports from Municipal and village officers regarding outbreaks of cholera, a disease which is readily recognized by the people in rural as well as urban areas. The Municipal law, also, in the towns of Bombay and Calcutta imposed on every medical practitioner who treated or became cognizant of the existence of infectious disease in any private or public dwelling, other than a public hospital, the duty of giving information without delay to the executive Health Officer. This obligation was not imposed in Municipalities generally, and it did not extend to any of the relatives, or to any of the attendants of the sick person, but only to the medical practitioner in charge of the case.

Thus, when plague made its appearance in India, special means had to be devised for obtaining early information regarding cases of plague, if possible during life, or, at any rate, after death. Some of the methods adopted for finding cases during life have been also utilized for the discovery of cases after death.

II.(1.)—*Measures Adopted with a view to obtaining Information of Plague Cases before the Death of the Patients.*

Methods adopted for finding plague cases during life.

575. In some cases private individuals were required during an outbreak of plague to notify sickness generally or plague in particular. Arrangements were made to place people arriving from infected areas under surveillance. Rewards were paid to persons giving information of cases of plague, and paid informers were utilized to discover cases. In infected towns volunteer agencies were used to assist the official establishments in collecting information regarding the occurrence of cases of plague. Special establishments were engaged on searching villages in the neighbourhood of infected places. In some places there was house to house visitation, and the search of houses in order to discover cases.

II.(1.)(*a.*)—*Notification of Sickness.*

Notification of sickness generally or of plague in particular.

576. The village headmen have generally been required to report cases of plague occurring in their villages.

The obligation of reporting sickness generally, or plague in particular, has been imposed in several towns on private individuals. We were given details regarding the working of this measure in Poona and Surat.

Notification of sickness in Poona.

In Poona, in a period of about eleven months between January 25th and December 31st, 1898, 2,954 cases of sickness were reported, of which 972 resulted in death. The

21,380, 21,986, number of dead bodies examined at Poona in the calendar year 1898 was 3,035, exclud-
21,991, 22,005. ing the bodies of persons who died in hospital, so that it is estimated that during this
21,416. period of eleven months there should have been 9,000 cases of sickness. The penalty
21,887. for not reporting a case of sickness was not enforced, and this probably had more than
anything to do with the comparatively small number of reports made. Relatives or
21,883, 21,991, friends reported 402 cases and native practitioners 1,117. Very few of the latter cases
22,005. were seen by the medical officers responsible for visiting those reported to be sick.
21,380. From March to the end of December about 25 cases of plague were discovered among
21,379. the persons whose sickness was reported. There were, in the calendar year, 106 deaths
from plague among persons whose sickness was not reported either by relatives or
21,386. medical practitioners. The cases of plague found by means of reports of sickness were,
many of them, in the early stages.

Notification of In Surat the system of reporting cases of sickness was developed and improved
sickness in Surat. during the course of the second outbreak. At a late period of the outbreak a special
15,836. inducement was given, at first in two wards, and subsequently elsewhere, to the people
16,004. to report plague by notifying that "if the inhabitants of a house or the neighbours
brought information of a plague case, the houses on each side of the plague case
would not be disinfected nor would the inhabitants be segregated." A considerable
number of cases of plague evidently escaped detection during the outbreak, but it is
16,005, 16,032. claimed that the system was successful during the later months of the outbreak.

Conclusions We think that it is not practicable to gain much, except at places well supplied
regarding notifi- with official medical establishments, by requiring reports of sickness to be made by
cation of sickness private individuals during outbreaks of plague. There is the danger that medical
by private attendants may omit to report cases, owing to the fear that reporting them may injure
individuals. their practice, and there is the danger that the relatives, friends, and neighbours of
the sick will not report owing to the fear of consequences unpleasant to themselves.
We think that the measure will be found useful only where the medical establishments
employed are sufficiently strong to take advantage of it, and where the obligation can
be efficiently enforced: and, when it is enforced, we think that a fee might well be paid
to medical practitioners in recognition of their services in making a report.

II.(1.)(*b.*)—*Surveillance of Persons coming from Infected Areas.*

Surveillance. 577. The above remarks refer to the notification of sickness among the residents of a
Nathan's "Plague place. Special arrangements have been made, mainly in places not attacked by
in India, 1896–7." plague, to detect cases of plague among arrivals from infected areas. As early as
Vol. III., March 1897, arrangements were made throughout the greater part of India to have
App. VIII., the names and destinations of persons arriving from the infected areas recorded at the
Nos. 69–89. railway stations and forwarded to the towns or villages to which they were going, in
order that a watch might be kept on them in their homes and any suspicious illness or
death promptly reported and inquired into. In some Provinces there was a special
observation of the health of all the people, whether they had been away anywhere or
not, in places known to be in close communication, commercially or otherwise, with
Bombay and other infected localities.

The surveillance The system has acquired fresh importance as the impracticability of detaining in
system in Bombay. observation camps all persons on their arrival from infected places has come to be
universally recognised. It has naturally been resorted to more within the Bombay
Presidency than elsewhere. The Bombay Government in October 1898 issued elaborate
and detailed instructions, of general application, both for urban and rural areas. The
system had already been working for some time in all the chief towns of that
Presidency whilst they were uninfected. The arrangements differed to some extent in
different places, but the general principle of them was that no person arriving by rail
21,528. was allowed to enter a town unless he was vouched for by some respectable native
gentleman, and unless his place of residence was intimated to the authorities. To meet
the case of persons who succeeded in entering the town either by road or by evading
observation at the railway stations, householders were required to make a report
regarding every person arriving in the town. All new arrivals were required to
present themselves for observation at stated intervals for a period of 10 days.

The surveillance In the Madras Presidency also elaborate arrangements have been made for the
system in Madras. observation of people entering it from infected areas. Along the frontier adjoining the
3865–70. Bombay Presidency and the States of Hyderabad and Mysore, there is a double row
3929–35. of circles with a diameter of 10 miles, so that a strip 20 miles broad all along the
3942–61. border is under observation. In each circle there is a special staff for the observa-
tion of persons coming from beyond the border. People who appear suspicious or are
not able to give trustworthy addresses are detained. On the main roads there are
frontier road stations, and similar arrangements are made at the railway stations.
Every person crossing the frontier is liable to be examined. If healthy he is given a

passport requiring him to present himself for 10 days to the head of the village to which he is going or other authority named in the passport. The counterfoil of the passport is sent to the latter. Lieut.-Colonel King, I.M.S., stated that this system had worked well. It had not indeed been possible to prevent everybody from coming in without a passport, but the instances where people succeeded in coming in without passports were rare. A certain number of persons had also evaded the duty of reporting themselves. The number who failed to report themselves, though only 2 per cent. in Madras City, was as high as 12·6 and 10·5 respectively, in the frontier districts of Bellary and North Arcot. It was said that many of those who failed to report themselves in these two districts were people who had come across the frontier to attend a market, or for some other temporary purpose, and then returned.

Conclusions regarding surveillance.

Some form of surveillance over persons arriving from infected areas is desirable at places in the neighbourhood of such infected areas, or in frequent communication with them. We think that there is no doubt that the system in the towns in the Bombay Presidency may often have been of use in deferring, though it may not have been able to prevent, an outbreak. A system of surveillance depends for its success on the active and intelligent co-operation of the people themselves. It may be expected to be most effective in places the inhabitants of which have experienced one outbreak, and, knowing the miseries of it, are anxious to avoid another. It is impossible to take absolutely effective measures to prevent strangers from entering an Indian town surreptitiously, and, even where the people co-operate most thoroughly in working a system of surveillance, there is a danger that the defence may be broken down in this way. Still we think it is one of the most useful means of preventing a healthy place from becoming infected.

In rural areas also the surveillance of persons coming from infected places may, we think, be of service. It is not so easy for outsiders to enter a village as to enter a town without being observed, and in tracts where the people are familiar with plague, a stranger, who is not related to any influential resident, will generally have difficulty in settling himself even temporarily in a village.

II.(1.)(*c.*)—*Rewards for Information of Plague Cases.*

Rewards for information regarding plague cases 5439.

578. The system of granting rewards, or of employing paid informers, for the discovery of plague cases was not adopted extensively, but it was resorted to in certain places. In the villages in the Hyderabad State, a reward of Rs. 10 was always given to anyone who reported a *bonâ fide* infected village which had not already been reported by the officials. The system was said by Mr. Stevens to have acted admirably, and to 5440–5442. have resulted in the discovery of a number of infected places. In the beginning of March 1898, a system of giving a reward of Rs. 50 for each authenticated report of 9934. the first case in a newly infected village was adopted in the Punjab. Captain James, I.M.S., who had great opportunities for forming a judgment on the manner in which the system worked, considered that it had worked very well indeed, and that no drawbacks 9936. had been found to it. Captain Clarke, I.M.S., who had not had so much experience of 10,829. its working, considered that the results secured from it were encouraging. In the Cutch State rewards were given to the poorer classes, of 4 or 8 annas, for reporting a case 13,436. among themselves. In Surat City rewards were given for each case reported. At 15,575–9. first the reward was from Re. 1 to Rs. 2, and afterwards it was increased to Rs. 10 for each *bonâ fide* case of plague. Only 33 persons obtained a reward. In addition to the rewards paid to private individuals, rewards were paid in Surat to police constables and sanitary inspectors who reported cases. In Sukkur rewards of from 8 annas to 18,386. Re. 1 were paid for information.

Conclusions regarding system of rewards.

There are, undoubtedly, disadvantages in a system of granting rewards or paying informers for the discovery of plague. It is possible, though very improbable, that a person suffering from plague might be taken into a place merely with the object of procuring a reward. The grant of a reward, too, may cause ill-feeling between the village in which plague is reported and that in which the person making the report resides. It is even possible that it may lead to misconception as to the motives of the Government, since at one time in certain parts of the country the people believed that deliberate efforts were being made by the authorities to spread the plague. But we think that these considerations may be ignored. The advantage of obtaining prompt information of early cases, even in a few instances, may be very great, and experience of the system of granting rewards is generally strongly in its favour. It appears to us that it will be found a useful measure, provided that the reward offered is substantial enough to be attractive, and that it is paid with as little delay as possible after the information has been given and ascertained to be true. The employment of paid spies or informers is a measure to which there are obvious objections, It may, however, be necessary to utilize this means of getting information as to plague cases so long as the people do not come forward readily themselves to give it.

II.(1.)(*d.*)—*Employment of Volunteer Agencies for the Discovery of Plague.*

Volunteer agencies for the discovery of plague.

579. As a matter of course, Government establishments of every sort have been utilized on plague duties of all kinds. They have been assisted by private individuals in most of the infected towns in the Bombay Presidency and elsewhere; some of these were Europeans, but the large majority were natives of India. The chief function of these volunteers has been to assist in the discovery of cases. In some towns, as, for instance, in Poona in 1898, an organisation of volunteer committees was in existence prior to the occurrence of indigenous cases of plague. Where no such organisation existed before the outbreak of plague, steps were generally taken to create one on its occurrence. The first step was to divide the town into a number of wards or circles, each under a ward officer or superintendent. Besides a certain paid staff there were associated with each ward officer a number of residents of the town who assisted him in making inquiries and discovering new cases. The ward again was divided into a number of blocks, of about 100 houses each, under supervisors. A rough census was taken as soon as possible and kept up to date by the entry of all new arrivals and the striking out of all departures. The duty of the supervisors was to make inquiries from house to house and obtain information of fresh attacks from the friends of the patients, from the neighbours, from paid informers, from detectives, and any other possible source, and to communicate it to the ward officers, who were responsible in the first instance for the disposal of all matters connected with the administration of plague measures within their wards.

Necessity for official assistance and control of volunteers.

Where in a system of this sort the ward officers were themselves volunteers, and there was no strong official element in the background to give support, it was liable to break down under the stress of a severe epidemic. At Bangalore, for instance, the ward superintendents were at first all non-official, both in the City and the Civil and Military Station. As soon as the epidemic began to press severely, the voluntary agency failed entirely; some resigned and some ran away; there was a panic, and the whole machinery was disorganised. The authorities had then to resort to a paid agency. At Surat, on the other hand, there was from the time when the ward system was introduced, at the head of eight, at any rate, out of the nine wards a European official; and the position of the large number of native gentlemen who volunteered for plague work was that of honorary assistants to these officials. Mr. Moore, the Collector, considered that this system worked very successfully.

2553.
3273.
24,417.

Employment of volunteers in Bombay City.
1344–9.

In the City of Bombay at the present time the volunteer element holds, perhaps, so far as the discovery of fresh cases goes, an intermediate position between that which it held in Bangalore and that which it held in Surat. The City is divided into nine divisions, each under a district officer, seven of the district officers being European military officers, one a Muhammadan gentleman from Sind, and one a native medical officer. Besides a staff of doctors, sub-inspectors and coolies, the district officer is assisted also by committees of volunteer native gentlemen. There are throughout the City about 900 gentlemen serving on these committees. They distribute the section of the town in which they are employed among themselves and visit it daily. They endeavour to find out cases of plague, and communicate the information which they collect to the district plague officers. Some of the committees have been very successful; others, judging from a comparison between the deaths reported from all causes and the number of plague cases discovered, have been less so.

Conclusions regarding volunteer agencies.

The employment of influential and trustworthy residents of a town to collect information regarding the occurrence of cases of plague must be of material assistance to the authorities. It would be impossible to provide official agencies of sufficient strength to undertake this duty in cities like Bombay and Calcutta, and even in towns of much smaller size when a number of them are simultaneously infected. Moreover, unless there be an intermediary between the representative of Government and the people, there is constant danger that the requirements of the authorities may be misunderstood. The risk of concealment of cases is lessened where people see that the influential residents of the place have ranged themselves on the side of the authorities.

II.(1.)(*e.*)—*Special Observation of Health of Persons in places exposed to Infection.*

Inspection of villages in the neighbourhood of infected places.
13,128.
19,479–80.
9669.

580. In consequence of the special danger to which places in the immediate neighbourhood of an infected place are exposed, the authorities have endeavoured to maintain a watch over the health of the inhabitants of villages close to infected places. In the Bombay Presidency, officials—agricultural inspectors or vaccinators, relieved of their ordinary duties, or men specially employed for the purpose—have been sent to visit villages which appeared to be threatened by plague to ascertain by

the examination of the death returns, and in other ways, whether any of these villages were infected. Similar precautions have been taken in other provinces. Since there has been plague in the Hyderabad State, the villages on each side of all the roads 5153. leading from the infected areas to the city of Hyderabad have been periodically 25,921. inspected. Each village within the observation circles of the Madras Presidency is 3954. inspected, usually every seven days, by the Sanitary Inspector. The most elaborate arrangement of this kind was, however, that adopted in the North-West Provinces, where about 400 square miles in the neighbourhood of Hardwar were brought under a 8863-7. special reporting agency. This area was divided into five divisions, each under a 9205-9. European officer, with a native medical subordinate. Each division was again subdivided into three or four circles in the immediate charge of a native official of the Revenue Department. Two European medical officers were also employed in travelling from village to village. A register was made of the inhabitants of every house. Each village within the area in close communication with Hardwar was visited every three days, and every inhabitant of the area was examined every eight days. In the villages further removed from Hardwar the examination of the people was less frequent. All cases of sickness were reported, and special inspections were made of the sick. As a result of these arrangements, combined with the other measures taken in the infected area in the North-Western Provinces, the spread of the infection beyond a very limited area close to Hardwar was effectually prevented. An organisation based on this model 10,272. was also employed in the infected tracts in the Punjab.

Conclusions regarding system of special observation of health of people in places most exposed to infection.

The advantage of keeping a special watch on the health of the people of places most exposed to infection is obvious. It may not be possible, except as an emergent measure, to entertain an establishment so costly as that employed in the North-Western Provinces, but, where the object aimed at is the protection of a tract of country as yet only slightly infected, it would be worth while to incur considerable expenditure on an organisation of this nature in the hope of preventing the spread of plague.

II.(1.)(*f.*)—*House-to-house Visitation and House Searches for the Discovery of Plague.*

House visitation and house searches.

581. Search parties have been used at different places with the object of detecting cases of plague which people are attempting to conceal. Sometimes they have consisted of soldiers or of police, or of other Government or Municipal establishments; sometimes mainly of volunteers supported by the presence of soldiers or police. In cases in which soldiers have been employed in the actual conduct of searches, they have generally been accompanied by respectable native gentlemen in order to give confidence to the people, and ensure the search being carried out with as little interference with their customs and injury to their feelings as possible.

Attitude of the people towards house searches.

There were many reasons why the search of their houses was likely to excite distrust and alarm among the people. The idea of such a search in order to discover cases of sickness was novel to the native of India, who is at least as averse from the invasion of the privacy of his house as an inhabitant of Western Europe. The females of the better classes of Muhammadans everywhere, and of Hindus in many parts of the country, do not appear in public. Some parts of a Hindu's house, such as the god-room and cook-room, are, by religious custom, closed to people of other races. And, although the attitude of the people towards the search parties is reported to have been sometimes friendly, house-to-house visitation, followed by searching, has not unnaturally been an unpopular measure almost everywhere. Speaking of Bombay, 25,554. Mr. Du Boulay said that it was "intolerable to the people." House searches were Para. 6 of Bombay Govt. Resoln., No. 4,108. P. of 25th June 1899. found at Surat to be viewed by the people with "unreasoning terror." The authorities of the Mysore State determined not to adopt house-to-house visitation, because they 3279. anticipated that the people would resent it. The objections of the people were apparently increased by the employment of soldiers at house searches. It is not 18,388. surprising that they should associate the presence of soldiers at the search of a house with a possible use of force, and it is not unnatural that it should have enhanced the dislike entertained by them to the measure. But the actual conduct of the troops, British and native, on the work of searching, did not warrant this attitude on the part of the people. The behaviour of the soldiers in carrying out this disagreeable duty is reported to have been exemplary.

System of house searches successful in some places.

Where, as in the areas which were infected in the North-Western Provinces and the Punjab, the establishments at the disposal of the authorities were very strong, the one thorough search which was generally carried out as soon as it was discovered that a place had been infected, was, it appears, usually successful. In the Canton- 10,908-13. ment of Poona also practically all the cases were discovered during life by means of 21,216. house-to-house searches. The staff was strong enough to visit almost every house each 21,259. day. 21,269. The population to be dealt with numbered only 15,000, was more or less habituated to military discipline, and free from the unreasoning fear of the soldiers that displayed itself at other places. The result of employing search parties is also said

14,218-9 11,270-2. to have been good at Ankleshwar, and in the Trans-Lyari portion of Karachi. But Mr. Giles said, that without a military cordon it was utterly mischievous in the town of Karachi itself, because it scattered the people all over the place. He guarded this statement by observing that in many cases the people did not get information of an intended search, and so were unable to disperse before the search party arrived.

In many places, and particularly in the large towns of Bombay, Surat, Poona, and Baroda, the search parties met with little success in detecting cases.

House searches in Bombay City.

Gen. Gatacre's Report, pp. 177-181.

The system of house-to-house searches was first tried in Bombay while General Gatacre was Chairman of the Plague Committee, and was continued there until March, 1898. For some weeks in the early part of 1898, about a hundred men of the Durham Light Infantry and a few native soldiers were used in one ward of Bombay for the actual work of searching. But, with this exception, troops were not used in Bombay City for the actual searches: they were used only for supporting them by patrolling and cordoning the areas to be searched. The persons who conducted the actual searches were generally a qualified medical man, either European or Native, and a lady doctor or nurse. They were accompanied by a sub-inspector and two or more police or military sepoys. The District Officer and the officers in charge of sections and sub-sections went round with one or other of the search parties, and, if possible—though this was often difficult—a local Justice of the Peace or Volunteer was attached to each.

Results of house searches in Bombay City.

The general conclusion of those who have had most experience during the later stages of the epidemic in Bombay City, is that house-to-house visitation, although it resulted in the detection of a certain number of cases, was not a successful means 8259. for combating plague. "The people dislike it," said Captain Bingley, "and the more energetic the District Officer becomes, the more will the people attempt to elude the results of his work by removing their sick, and by going from one district to another to escape him. We could not get any information at all; 10,949-51. at any rate it was very rare." Major Ross, with his large ward of 140,000 inhabitants, and only 150 men to use for searching, found it impossible to do more than make raids at odd times on the very worst localities where the lower class people lived. He thought that he did not discover even 30 per cent. of the cases 18,464. that occurred. Mr. Roughton, indeed, succeeded by rigorous house-to-house searches in freeing his own district from plague, but he did so by driving it out of his district into other wards. This result also happened elsewhere. Lieutenant-Colonel 489. Wilkins, I.M.S., states that when a search party came into one district, plague 25,794. cases were carried into another one. Mr. Firth told us that his ward became gradually infected by plague coming from other wards. When the plague staff got energetic in other wards, he said, "they came into my section." Mr. Stewart 16,987. found that "in Bombay, with its immense chawls full of lodgers, who have little kit and can shift at any moment, house-to-house visitation is of comparatively little use." 8257. In March 1898, the system of house-to-house visitation and searches was abandoned in Bombay, and replaced by the present system under which volunteer committees are used for the purpose of discovering cases of plague.

House searches in Surat.

24,417. Experience in Surat was very unfavourable to the system of house-to-house searches. Troops were not employed there. Each search party consisted of one or two European gentlemen and a party of police. "I am bound to say," says Mr. Moore the Collector, "that as far as the search went, it did more harm than good, because it was almost impossible to conceal from the people where we were going to. The consequence was that they removed patients before we came, and therefore infected fresh houses. Plague went on, and the mortality continued to rise until November." 16,004. "House-to-house search," says Mr. Judge, who was engaged for some time with the search parties in Surat, "was of no practical utility, and inflicted the maximum of inconvenience on the people with minimum results as to the discovery of plague." It was abandoned at Surat in November, 1897.

House searches in Poona.

Mr. Rand's Report, paras. 6 and 7, and Chap. III.

Search parties were employed in the first outbreak at Poona. At first British soldiers alone were employed. With each party there went a native gentleman to act as interpreter, and to point out to the soldiers which the parts of the house were that custom forbade to them. Subsequently the constitution of the search parties was altered from three British to two British and one native soldier. The attitude of the inhabitants of the city towards the search parties is described by the late Mr. Rand, in his report upon the outbreak at Poona, as having been "on the whole friendly, though people who had sick in their houses usually tried to conceal them." And he sums up the results as follows:—"From March 13th to May 19th, 218,124 houses were searched, and 38 plague cases and 64 corpses were found. The houses in the city were searched, on an average, 11 times each. The sufferers from the plague were removed to hospital, and arrangements were made for the prompt disposal of the corpses. The full value of the work done by the search parties cannot be gauged by the number of cases they discovered. The institution of the search by the military had the effect of causing the public to give information to the Municipal authorities of a large proportion of the cases that occurred, and in many instances even to take patients to hospital without official pressure having been exercised."

21,494, 21,526, 21,576.

During the second outbreak at Poona search parties of British and native soldiers were again used, and were assisted in their work by native gentlemen. A comparison between the mortality in excess of the normal mortality and the reported plague mortality in the two outbreaks at Poona shows that, in spite of the search parties, people succeeded in concealing plague to a great extent.

House searches in Baroda City. 14,600-3.

In Baroda City the State authorities organised search parties without soldiers. The result does not seem to have been satisfactory. The official in charge of the town did not consider that the committees had worked very satisfactorily, and it was found that the sick were carried about from house to house to escape detection.

Conclusions regarding house searches.

House-searching cannot be made a popular measure, and its efficiency, like that of most other unpopular plague measures, depends on the proportion which the establishment available for doing the work bears to the amount of work to be done. It is a struggle between the authorities on the one hand trying to discover the cases, and the people, on the other hand, trying to hide them, and whichever side is the stronger wins. It is, indeed, possible that, with very strong establishments and with a very limited amount of infection to deal with, a system of house-to-house searches may result in the detection of nearly every case of plague. Where such conditions exist, the advantages of house searches may possibly more than counterbalance the objections to them. But this will rarely be the case, and in other conditions house-to-house searches will be unproductive of good, as well as irritating to the people.

II.(1.)(*g.*)—*Conclusions regarding Measures for obtaining Information of Plague Cases before the Death of the Patients.*

General remarks regarding measures for obtaining early information of plague cases during life.

582. As will be gathered from what we have said above, very great difficulty has been experienced in devising any effectual means for the discovery of cases of plague. With the exception of house searches, the objections to which we have just stated, and surveillance, which is obviously inapplicable to the permanent residents of a town of considerable size, every available method for discovering such cases depends on some one coming forward to give information. The essential difficulty is that no one will come forward to give information unless he sees reason to hope for some benefit as the result of his doing so. The members of the sick man's household have no motive for reporting his sickness, except when the patient becomes delirious and unmanageable: on the other hand they have every motive for concealing it lest they may be subjected to plague measures themselves. The medical attendant has no motive for reporting cases, because, if he does so, he will lose his practice. Even where the failure to report a case of plague renders the relatives or medical attendant of the sick man liable to punishment, the prospect of being punished is too uncertain to weigh against the certain inconveniences that must result from coming forward to make a report. The neighbours have, indeed, a motive for reporting a case of plague, viz., that of getting rid of a source of infection which may be dangerous to themselves. But this is neutralised and even outweighed by the fear that, as the result of making a report, they may be themselves troubled by plague measures. The only persons who have a direct motive for making a report are those who can feel assured that they will not, by doing so, expose themselves to any inconvenience, and can also obtain a pecuniary reward by reporting a case. News of an attack of plague, at all events if it is an indigenous case, is, however, seldom likely to penetrate to persons residing so far from the sick man's house that they can feel certain that their giving information of his sickness will not eventually involve them in some disagreeable consequences.

Ever since the epidemic of plague began, continuous efforts have been made to devise some means of overcoming the difficulties in respect of obtaining information of cases of plague during life. But the problem of inducing people to give information, which probably will, so long as there are any plague measures at all, involve them in inconvenient consequences, is one of which no satisfactory solution has yet been found.

II.(2.)—*Measures Adopted with a view to obtaining Information regarding the Occurrence of Plague Deaths.*

II.(2.)(*a.*)—*Registration of Deaths.*

Death registration in India.

583. Deaths have been registered in both urban and rural areas in India for a number of years, but improvement in registration has been of slow growth, and the system is not yet an efficient one, especially as regards the record of the cause of death.

The laws in force in the Municipalities in different provinces in India all contain provisions regarding the registration of deaths within Municipal areas.

Provisions of the City of Bombay Municipal Act. Bombay Act III. of 1888, Chapter XVI.

In Bombay City there are District Registrars, and a Municipal Officer has also to be appointed at every place for the disposal of the dead for the purpose of registering particulars regarding the death of every person whose corpse is disposed of there. The obligation of reporting particulars concerning a death to the registering officer is imposed on the nearest relatives present at the death or in attendance on the deceased during his last illness, and, in default of such relatives, on each person present at the death, and on the occupier of the premises. In their default, each inmate of the premises, and the undertaker or other person causing the corpse of the deceased person to be disposed of, is required to make the report which has in all cases to be made at or about the time that the corpse is disposed of. In the case of a person who has been attended in his last illness by a medical practitioner, the practitioner is required to furnish a certificate of the cause of death to the Municipal authorities, and deaths in the hospitals have to be certified by the Medical Officer in charge. A breach of these obligations is punishable with fine.

Provisions of the Municipal Law in Calcutta. 6509–15.

In Calcutta the provisions regarding the registration of deaths are substantially the same as in Bombay. In speaking of the system there, Dr. Nield Cook, the Health Officer at Calcutta, observed, "We have men at the burning and burial grounds who register all the deaths of the bodies brought there for cremation or burial; so that, as a matter of fact, we get the numbers tolerably accurately. But, as most of these people have never been seen by men with any knowledge of rational medicine, and the registrars themselves have no knowledge of it, we have no exact information" as to the cause of death, and reliance has to be placed on the word of friends. How inaccurate the reports can be is illustrated by the evidence of Rai Bahadur Kailas Chandra Bose, within whose personal knowledge it came that the relatives of two persons who died of plague registered the deaths as due, in one instance, to chronic rheumatism, and in another to chronic dysentery. Speaking in general terms of the registration of deaths of Calcutta, this witness remarked, "the mortuary returns of our town are not very satisfactory; they only give an idea of the general number of deaths, but not an idea of the causes of death."

7525.

7522.

Provisions of the Municipal Law in Madras City.

In the City of Madras the corresponding regulations regarding the registration of deaths impose the obligation of reporting on the relatives or attendants of the deceased, or, in their default, on the occupier of the premises in which the death occurred, but no obligation is placed on medical officers to report, except in the case of patients dying in hospital. The Health Officer at Madras, Lieutenant Cornwall, in speaking of the returns of death in Madras City, described them as "fairly accurate." This remark applied only to the number of deaths, for, he added, "the people report a large number of cases themselves. There are peons at all the burial grounds, whose duty it is to report all the cases that come to be buried there. They take down names and addresses of the people, and the disease from which the person was supposed to have suffered. That, of course, merely resolves itself into either fever or cholera or diarrhœa." He stated that the cause of death was "generally inaccurate."

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4354.

Provisions of the law in District Municipalities.

The provisions of the law in district Municipalities in Madras is the same as in Madras itself. The Commissioners of any Municipality within Bengal can be required, at the instance of the Local Government, to make provision for the registration of deaths. And in the Presidency of Bombay, in the North-Western Provinces and Oudh, and in the Punjab, the provisions of the law take the form of empowering a Municipal Committee to make byelaws regarding the registration of deaths with the approval or subject to the confirmation of the Local Government. We understand that as a matter of practice all Municipalities within British India have taken steps to provide rules for the registration of deaths. From evidence which has come before us, however, it would appear that the rules have, in the case of some Municipalities, not been strictly enforced, and in some cases the rules allow of an undue postponement of the death report.

23,308–11.
11,291.

Registration of deaths in rural areas.

In rural areas the duty of reporting is imposed on various village officers in different parts of the country and on the police establishments. The return of deaths made by the village officers eventually reaches the District Civil Authorities, the District Medical Officer, and the Sanitary Commissioner of the Province, but, when they have reached these authorities and an examination of them has disclosed the existence of any exceptional mortality, much time has been lost.

System of death registration in force before outbreak of plague inadequate.

584. When plague broke out in different localities in India, it was found that the system of death registration then in force was inadequate for the purpose of supplying the information which was required for combating the plague epidemic. This was, no doubt, due partly to the difficulty of recognising plague, and partly also to the fact that

plague deaths were concealed, while misleading or incomplete information was given with regard to the cause or place of death.

through difficulty of diagnosis and wilfully false reports of cause of death, and difficulty of ascertaining exact place of death.

The difficulty of recognising plague is not infrequently a real one. Easy as it may be for a medical man of superior qualifications to recognise an ordinary case of bubonic plague, it is a matter of some difficulty, even for him, to diagnose pneumonic or septicæmic cases. In the case of a native subordinate of the Government Medical Department these difficulties are greater, and greater still in the case of the unqualified native practitioner. The people themselves may have the greatest difficulty in recognising the disease. The Health Officer of Bombay said, "the real difficulty is the recognition of the disease." 1050 "In the great majority of cases," said the Sanitary Commissioner of 8867. the North-West Provinces and Oudh, "they would not know it was plague; they would omit reporting it from sheer ignorance." On the other hand, when plague is prevalent, there is the opposite risk that deaths due to other causes will be attributed to plague. Major Anderson, I.M.S., said, "When village officers once report plague, they are 23,289. very apt to put down every death which occurs as plague. If death occurs within a week of a man falling sick it is put down as a plague case."

Even when a death was known to be due to plague, it was often wilfully reported as having been due to some other cause.

There was in the largest cities the further difficulty of finding out the exact house of death. In his report on the plague in Bombay City, Sir James Campbell remarked, "During the past epidemic, in a large proportion of daily deaths, perhaps in one fourth of the whole, the place of death has not been recorded in the cemetery returns with sufficient clearness to enable the case to be traced." And, in another passage, he stated that "the efforts to conceal plague cases and death, with the object of escaping house disinfection, segregation of contacts, and other unavoidable annoyances, have been very successful, and have been, to a great extent, due to the imperfect registration of the house of death."

Sir James Campbell's Report, p. 60.

As we have already observed, the number of deaths not reported at the time to be plague in Bombay City has probably, since the place was first attacked, exceeded 30,000.

Improvements in system of death registration in places attacked or threatened with plague.

585. Owing to the ordinary system of death registration being ineffective in giving even an approximate return of the deaths from plague, attempts were made to improve it in places, chiefly towns, attacked or threatened with plague. The first object being that the plague authority should learn of a death as quickly as possible, the people were in many towns required to report deaths, not to the Municipal authorities, as in ordinary times, but directly to the Plague Officer. They were also required to report 6791-3. deaths immediately, instead of after the somewhat long interval sometimes allowed to them by the rules. In the largest towns, Calcutta and Bombay, no change was made in the ordinary system under which information of the occurrence of a death is given to registering officers stationed at the places where bodies are disposed of. But in these two towns, as in others, a system was instituted of making, as soon as possible after a death was reported, careful local inquiries for the purpose of fixing the exact house of death, and of learning all such circumstances attending the death as would show whether the cause of death was plague or not. These subsequent local inquiries have been very valuable. Even in the large city of Bombay they materially 25,617. reduce, as mentioned by Mr. Du Boulay, the difference between the plague mortality reported each day and the excess of the actual over the normal mortality for that day, though there is no doubt a large number of cases in which the fact that an individual died of plague is not discovered as early as is necessary, and probably a smaller balance of cases in which the inquiries are inconclusive.

II.(2.)(*b.*)—*Corpse Inspection.*

Corpse inspection carried out in certain places.

586. Another method employed in certain places for the purpose of determining whether death resulted from plague or not was the actual examination of the dead bodies. This measure has been used in two sets of circumstances

It has been used in a place in which the presence of infection was suspected in order to discover whether infection existed or not. It has also been used in a place known to be infected, in order to secure, as far as possible, that no house in which a death from plague had taken place should remain undiscovered. From time to time, with either one or other of these objects, it has been put in force in the towns of Karachi, Hyderabad, and Kotri in Sind, in Poona City and Cantonment, at Sholapur and Satara, in the Porbandar and Palanpur States, in Bangalore City, Bangalore Civil and Military Station, Mysore City, and a number of small towns in the Bombay Presidency.

It was also adopted in some of the rural areas which were infected in the Bombay Presidency and in the Baroda State, in Hardwar and the neighbouring places attacked by plague, and in the infected villages in the Punjab, and in the Hyderabad State.

12,777-8, 18,132-4, 12,554,
21,356-77
21,261, 21,299.
23,881, 22.481.
13.730, 13 166.
25,101-5, 14,281,
22,185.
22,629. 14,665.
9191-9204.
10,252-7.
5928-31.

1129, 6513-5. It was not one of the measures put in force either in Bombay or Calcutta.

At a number of the places at which it has been tried, corpse inspection has not been carried out under the strict conditions requisite to gain the full advantages from it. These are, firstly, that every body in respect of which there is not a certificate from a trustworthy medical attendant that death was not due to plague, must be examined by a member of the medical staff employed on plague measures, and, secondly, that the body must be examined not at the burning ghat or cemetery but at the place of death, so as to ensure that the house in which the death took place is known. In some instances, female bodies were exempted from examination. At other places, the examination was conducted at the cemetery or burning ground.

Such relaxations undoubtedly make the system of examining dead bodies less irksome, and the fact that they were allowed at certain places shows that the authorities sometimes felt that it was not advisable to insist on its being strictly carried out. But, though such relaxation may lessen the people's objection to corpse inspection, they diminish the advantages which would result from rigidly carrying it out.

Attitude of the people towards corpse inspection.

587. As regards the attitude of the people towards corpse inspection, it is an undoubted fact that it has been undertaken at a number of places without any serious 21,260. objection to it having been made by the people. 21,825. No objections of any importance were made against it at Poona. 21,373. That the people at Poona had not any strong feelings in the matter appears to be clear from the evidence of Mr. Patwardhan, a member of 21,375. the Municipal Committee. He observed: "Examination of corpses was strictly carried 21,549. out. It ensured correct registration of deaths from plague, and enabled the authorities to trace out every affected locality where a plague death had occurred. In some cases the examination was delayed for several hours. With us, the dead body is to be removed from the house to the cremation ground as early as possible. But if a death took place at 10 p.m. in the night, the dead body had to be kept in the house till 10 a.m. next morning, to allow of its inspection by the Plague Medical Officer. This delay in the examination of corpses caused great annoyance. Corpse inspection is a necessary measure in times of a plague epidemic, but arrangements must be made for examination at all hours of the day and night. It is a necessary measure, but it should be carried out with as little inconvenience to the people as possible."

22,481-3 In the neighbouring town of Satara, corpse inspection was carried out without 23,879-8 objection, and the same was the case at Sholapur, and in smaller towns in the Bombay Presidency in which it was tried.

In Sind also, corpse inspection seems to have been carried out without creating 11,284. opposition on the part of the people. Mr. Giles, the Commissioner, observed: "Of course, it is very disagreeable to the people, although the people of Sind are much easier to deal with than people in most parts of India. We did not meet with violent opposition, and the people behaved extremely well. But there are many 3802. classes to whom it is no doubt repugnant to their feelings." Mr. Cadell said 3806. that no objection was found at Karachi. He did not think that the people liked it 18,132-3. anywhere in Sind. It was not objected to at Kotri, Hyderabad, or Rohri. Mr. 12,521. Gidumal Lekraj, who was employed as a volunteer on plague duty at Karachi, gave it as his opinion that the people objected to corpse inspection, even although it is well conducted, "because it is against the Muhammadan and Hindu religions to touch a corpse after death."

9192-3. Speaking of corpse inspection at Hardwar, Mr. Winter said: "They do not like it . . . There was no rioting over any question of corpse inspection. They disliked it, and that may have been one of the causes which led to a small disturbance that occurred, but it was not the immediate cause." Lieutenant Colonel Thomson, 8809-10. I.M.S., said that the people disliked it, but modifications in the system whereby inspection was dispensed with in cases where the cause of death was certified by a 13,435. regular practitioner, "induced them to adopt it without any serious opposition." 13,552. Speaking of Cutch Mandvi, Major Hyde Cates mentioned incidentally that the relatives very much object to their dead being examined.

In the town of Mysore corpse inspection was carried out without objection. This 25,101-5. was also the experience in the Punjab, both in the villages and in the smaller towns 10,253-7. in which it was tried, and in the villages in the Satara district.

Examination of female corpses.

22,747-9. 588. Difficulties arose at some of the places at which corpse inspection has been tried, with reference to the examination of female bodies.

Just before the second outbreak at Karachi the Muhammadans began to object, 3803. and asked for a lady doctor to examine female bodies. At Bangalore the Muhammadans often made objection to their houses being entered, and the 2711. Muhammadan females were examined only by nurses. At Porbandar the Muham-

madans objected to the examination of female bodies. When the plague was raging 13,730.
a nurse examined the Muhammadan females. After the disappearance of plague the
authorities ceased to insist on the examination of females. In the villages of the
Hyderabad State some of the Muhammadans objected to the examination of females, 5930–1.
and, in consequence, female bodies were not examined.

Feeling in Bombay City regarding corpse inspection. Sir James Campbell's Report, p. 23.

589. We have also some evidence as to how it might be regarded in Bombay City and
some other places where it has not been attempted. The question of attempting to enforce
corpse inspection in Bombay City was considered by the Plague Committee in March 1898.
The idea was abandoned on the ground that any attempt to enforce corpse inspection was
likely to give rise to active ill-feeling, and that the possible advantages from the practice
were outweighed by the certainty of discontent. Dr. W. Venis and Major Ross (who 19,924–5.
were employed on plague duty in both Bombay and Poona), while they were in 10,983–5.
favour of corpse inspection as carried out in Poona, were of opinion that it could
not be adopted in Bombay. Mr. Du Boulay thought that more complete information 25,618.
might be obtained from corpse inspection, but that it would cause much opposition.
Dr. Blaney, whose experience as a medical man in Bombay has extended over a very long
period, thought that it might be possible to have corpse inspection at the cemeteries 17,750.
in Bombay. Mr. Lund, a gentleman who had given much assistance as a volunteer
on plague duty, considered that it would be objectionable to all the people, particularly 17,886–7.
Muhammadans, and that it would not be of material assistance. Mr. Macdonald, also 17,967–70.
a volunteer worker during the epidemics in Bombay, told us that the people allowed
him to inspect corpses very freely, and, indeed, invited him to do so. His opinion was
that the people were quite willing to allow a European to examine bodies, but would
resent examination by a native of a different faith, and might even resent the examination of female bodies by any young doctor.

Feeling in Calcutta regarding corpse inspection.

590. Dr. Nield Cook, the Health Officer of Calcutta, considered that corpse inspection
would be of much help in determining whether plague was in Calcutta. When asked
whether there would be much objection to corpse inspection, he replied, "I think it 6605–7.
depends very much upon how it is done. With Brahman doctors, I think any
objection on the part of a Hindu would easily be got over as far as the males
are concerned. But as far as the females are concerned, I think it would be much
better left alone. It would cause so much trouble. After all, if we inspected
most of the males, it would give us a very good idea." He thought that the
people would not like female bodies examined even by women doctors. Dr. Kailas
Chandra Bose, a medical practitioner in Calcutta with considerable opportunities 7547–51.
for arriving at an opinion on the subject, thought that the people there would object
to the examination even of male bodies, and that they would resent being required
either to get a death certificate from a medical man or to submit to corpse inspection.

Possibility of corpse inspection in large cities of Northern India.

591. In answer to a general question as to whether, judged by his experience at
Hardwar, corpse inspection would be possible during an outbreak of plague in one of
the large cities of Northern India, Mr. Winter, the Collector of Saharunpur, said: "It
would want great tact. It could be done to a certain extent. If plague breaks 9247.
out in a very large town it would be most important to have corpse inspection at
the beginning of the outbreak, in order to ascertain if plague is spreading or not,
and to detect each of the earlier cases, to enable measures being in all cases
taken to stamp out the disease if possible. But if plague spreads all over the
town, there would be no necessity for insisting on corpse inspection. Corpse
inspection at the beginning of an outbreak could be arranged if you can get the
native leaders on your side." He thought that the people would object more later 9248.
on than they would at first. "I am talking," he said, "of the first few isolated cases
at the beginning. There would be many interested in stamping out the disease, and
they would overcome the objections of the few immediately concerned. I do not
think it would be possible to carry out the corpse inspection in a large town in
which plague had broken out in epidemic form, nor would it be necessary."

Conclusion regarding attitude of people towards corpse inspection.

592. There can, we think, be no question that corpse inspection is generally offensive to the feelings of the people. They dislike having to retain the dead body in the house till time has been given for the examination to be made. They object to a stranger touching any corpse, and particularly to his touching and stripping the corpse of one of their women. The fact that in places they have submitted to the examination of dead bodies without open objection does not, in our opinion, show that it has not been repugnant to them. The system has not been tried in the places where the people are likely to feel most strongly about it.

The efficiency of corpse inspection as a plague measure.

593. We think that, to warrant the adoption of a measure, which the people regard as they regard corpse inspection, it must be clearly shown that a very high degree

of advantage will result from it. We propose, therefore, to inquire whether corpse inspection is so pre-eminently useful as to justify its application in face of the serious dislike with which it is undoubtedly regarded by the people.

It is evident that the inspection of a body after death cannot, as a measure for dealing with plague, be as useful as an efficient system for procuring the prompt report of an attack during life. Infection may be spread by a person who recovers, or before his death by a patient whose death does not occur for several days after his attack. In the first case corpse inspection is obviously inapplicable; in the latter case, the information which corpse inspection gives may come too late to prevent the spread of infection. At best, then, it must, as a plague measure, be regarded only as an inferior substitute for a system which would secure that attacks of plague are promptly reported during life.

Difficulty of recognising certain cases of plague by corpse inspection.

594. It may be argued, however, that the chances of discovering plague during life are small; that reliance must be placed chiefly on the discovery of it after death; that for this purpose the inspection of the body is essential; and that the great bulk of plague cases are bubonic, and therefore easily recognisable after death.

It may at once be granted that corpse inspection would by itself result in the discovery of the great bulk of deaths that have been caused by plague. There are, however, a certain proportion of cases in which the inspection of the body will not establish the fact that the deceased has died of plague. We have already referred to the difficulty of diagnosing certain cases of plague during life. The difficulty of recognising the disease is enhanced after death. Mr. Giles, the Commissioner in Sind, under whose orders a number of medical men were engaged on corpse inspection, observed: "After death our experience is that plague cannot always be
11,366. diagnosed." This opinion is confirmed by that of medical officers who have been engaged on the work of corpse inspection. Captain Morgan, R.A.M.C., who had been
21,958. employed on plague duty at Poona for two years, gave it as his opinion that it was impossible in many cases to diagnose a case of plague by mere inspection of the corpse.
8811-14. Lieutenant-Colonel Thomson, I.M.S., after expressing his opinion that corpse inspection is a measure which must be adopted, added that, in pneumonic cases, it is only possible to go by the history. He admitted that the value of inspecting a body in such a case without a *post-mortem* examination would not be great. Captain Chaytor-
9434-5 White, I.M.S., was not, on his experience at Hardwar, prepared to say that he "could, in every case, swear to a pneumonic case by corpse inspection," and thought that the matter could only be made certain by a *post-mortem* examination. Captain
9544-9. Elphick, I.M.S., had observed œdema on the front of the thorax, extending to the upper arms, sides of the chest, and abdomen, in all forms of plague which he had seen
10,344-5; 10,379-83; 10,424-9; 12,403; 12,925; 15,926; 18,158-61; 18,557-8; 27,177-80. in Hardwar and the neighbourhood, and thought that a large number of cases of plague might be discovered by corpse inspection. But this form of œdema, which was so noticeable at Hardwar, has not been elsewhere observed, and Dr. Elphick himself could not be sure that one of the few cases, which he examined *post-mortem*, was a case of plague, even after that examination. Major Reade,
9552-3. R.A.M.C., expressed it as his opinion that pneumonic cases can generally be detected
21,732-3. by medical examination after death. He said, "One arrives at it by a process of exclusion mostly. There is a history of cough, and there is sometimes a very frothy condition round the mouth of the corpse—a congestion round the mouth and
21,465-8. nostrils." Dr. H. Venis, who was employed under Major Reade in carrying out corpse inspection in Poona, stated that he could discover a case of plague pneumonia from the history and appearance of the body. When asked what appearance of the body or what history would enable him to diagnose a case of plague pneumonia from a case of ordinary pneumonia, he replied that "it would have the appearance of plague," that if there was no bubo the clinical history would have to decide the point, and that a case of acute pneumonia would not necessarily differ from a case
18,922. of plague. Dr. W. Venis, who was also employed at Poona, said: "In some cases we had a suspicion of pneumonic plague, but of course, we could not be absolutely certain." Lieutenant-Colonel Henderson, I.M.S., employed at Hyderabad
18,135. (Sind) expressed the opinion that the presence of pneumonic plague could not be ascertained by means of corpse inspection. Major Collie, I.M.S., was emphatically of
20,017-8. opinion that plague cannot be diagnosed with certainty in a dead body found in the street, unless a bacteriological or microscopical examination is made, and that there was nothing special about plague pneumonia after death.

Corpse inspection in practice a defective method for discovering all cases of plague.

595. It is, we think, beyond doubt that a certain proportion of deaths from plague could not be attributed with certainty to that cause, even after the bodies had been inspected by thoroughly qualified European medical officers. The proportion which would escape would vary with the extent to which septicæmic or pneumonic plague might prevail. Where the medical officer employed on the duty of corpse inspection

(as was the case, for instance, at Cutch Mandvi, Bulsar, Umreth, Satara, Rohri, Kotri, and Ankleshwar) is a Hospital Assistant, the proportion of cases which will not be discovered might be still larger. In the case of females it will be especially difficult to look for a reliable result from corpse inspection. The examination of their bodies by a male doctor would, in many parts of the country, be impossible. The number of qualified lady doctors available to conduct such examinations is very small. The examination of a corpse by a nurse can be of no use in determining whether the death was due to plague or not.

II. 474, 16,170, 14,082-7, 22,482, 12,026, 12,735, 14,265-7.

Corpse inspection not recommended as a general measure; inquiries into history and cause of death will as a rule suffice for discovery of plague deaths.

596. It is impossible to say what proportion of plague deaths would remain undetected if corpse inspection alone were relied on as the means for discovering cases of plague after death; for wherever corpse inspection has been utilised it has been supplemented by independent inquiries into the cause of death. Such inquiries embrace the clinical history of the case, the connexion of the death with other suspicious deaths, the fact of the arrival, at the house, of an infected person, or of the deceased having himself gone to an infected place, and many similar questions. Corpse inspection, assisted by inquiries of this nature, would no doubt leave fewer deaths from plague undetected than such inquiries taken alone. The latter by themselves, if they are made promptly after the occurrence of death, ought, however, to make it clear in the great majority of cases, except in the very largest towns, whether the death was due to plague or not. In towns such as Bombay and Calcutta the residuum of deaths from plague which would remain undetected after such inquiries would, indeed, be not inconsiderable. but in these towns corpse inspection does not appear to us to be a practicable measure, though the President is of opinion that, even in these towns, circumstances may arise which would render the introduction of the measure beneficial. In other towns the residuum of cases in which the cause of death would remain doubtful would be considerably less. Amongst this residuum in which the cause of death is left undiscovered by inquiries alone, there would no doubt be a certain percentage in which the cause of death would be discovered by a medical examination of the body. Any measures for dealing with plague can be as effectually secured by adopting the assumption that these deaths were due to plague as by subjecting the bodies to a medical examination. This being so, and in view of the general repugnance of the people towards an examination of the body, we consider that corpse inspection is not to be recommended as a general measure, and that it should not be carried out anywhere except where Government sanctions it.

II.(2.)(*c*)—*Conclusions regarding Measures for obtaining Information of Plague after the Death of the Patients.*

General remarks on death registration in India.

597. In connection with the subject of obtaining early information of cases of plague, the question whether the ordinary system of death registration in India might not be made more effective for discovering deaths due to epidemic disease has naturally suggested itself We fear that it is not possible to effect any material improvement except very gradually; for its chief defects are not so much in respect of the numbers of deaths as in respect of the causes of them. They result in the main from the fact that very few of the people of India ever see a medical practitioner, qualified according to European methods, from the moment of their birth to that of their death. This is true, even in the most advanced towns in India. It is estimated that from one-third to one-half of the people of Calcutta have no medical attendant. The Health Officer considers that in Bombay the number is still smaller. He said "Previous to the appearance of plague in Bombay, I do not think that 10 per cent. of all dying were attended by medical men." In the smaller towns the proportion of the population attended by qualified medical men is even less, and the villagers are often dependent solely on the occasional visits of an itinerant medical attendant, who practises according to Oriental methods, and is entirely unqualified according to the European standard. The Head of the Indian Medical Service doubted whether five per cent. of the total population would before death be attended by a European medical officer or by a native medical officer practising with a diploma obtained at a Government medical school. It is obviously impossible to expect in a country so circumstanced a standard of death registration in any way comparable with that in Great Britain, where 98 per cent. of the deaths are certified either by registered medical practitioners or by coroners, or by similar officials after careful inquiry. The Indian Government cannot provide medical advice throughout the country generally. Thus the main cause of the imperfections in death registration is one that is beyond the power of the Government to reach. Direct information regarding the cause of death will, for many years to come, be very seldom obtainable; reliance

7783–7793, 8012, 8054. 7701, 6635, 15,834.

1132-3.

will largely have to be placed on that indirect information that is to be gathered from all the circumstances of the death, and specially from its relation to any other recent unexplained deaths.

Dr. Wright and Dr. Ruffer dissent from some of the above conclusions.

598. From some of the conclusions arrived at above, two of us, Dr. Wright and Dr. Ruffer, dissent, and they have expressed their views in a note which is published as an Appendix* to this Report.

III. MEASURES TO CHECK PLAGUE IN INFECTED PLACES.

III.(1.)—*Removal of Plague Patients to Hospital.*

Removal of plague patients to hospital.

599. The non-isolation of plague patients must always involve a certain amount of danger to the community of which they are members. The necessity for providing against this danger, and the possibility that patients would have a better chance of recovery in well-arranged hospitals than in their own houses, suggested that it would be a useful measure to remove plague patients to hospital.

Policy adopted in Bombay City.

Mr. Snow's Report, pp. 6-7.

600. The removal of plague patients to hospital was one of the first measures taken on the outbreak of plague in Bombay City. The exact conditions under which it was carried out have varied a good deal at different periods during the epidemic. Up to the end of October 1896, the policy was to remove all plague cases to hospital. Any person certified by a duly qualified medical authority to be suffering from plague was liable to removal to hospital even though he might be already provided with proper accommodation. The attempt to take all plague patients to hospital, however, created hostility and alarm. Reports were freely circulated that the authorities took people to hospital merely to make a speedy end of them. Crowds constantly collected round the ambulance vans and stoned them, and the officials of the Health Department were often in danger of their lives. Matters culminated on the 29th October in an attack on the Municipal Hospital by nearly a thousand mill hands. The shopkeepers began to close their shops, and as looting and severe rioting were anticipated, and it was feared that the sanitary staff—without whom Bombay would in a few days become uninhabitable—would make common cause with the rioters, proclamations were issued modifying the existing policy.

Mr. Snow's Report, p. 15.

The modifications then made were carried out for about four months, viz., from the issue of these proclamations to the appointment of the Plague Committee under General Gatacre. All attempts to remove patients to hospital were not indeed abandoned in this interval. But where proper isolation and treatment could be carried out in the patients' own houses, arrangements were invariably made to transfer them to the best lighted and ventilated rooms, and every endeavour was made to dissuade all but the few necessary attendants from frequenting that part of the dwelling. It was only where circumstances made it impossible to make any suitable arrangement or where the patients were paupers or friendless, that they were removed to the hospital.

Gen. Gatacre's Report, pp. 15-24.

With the appointment of the Plague Committee in the beginning of March 1897, there was a reversion to the first policy, and an order was promulgated that all cases of plague must be removed to the hospital at once. House to house searches were accordingly instituted to find the cases; and the number of Municipal, private, and caste hospitals was largely increased.

923-933.
8258.
25,559-61.

This policy—relaxed somewhat till plague began to rise again in the second outbreak—continued for about a year, when, in consequence of the feeling of irritation produced by the more rigorous of the plague measures, forcible house to house searchings were abandoned in favour of a system of inquiries by local volunteer committees. From this time also Plague Officers were permitted to exercise a discretion in the matter of removing patients to hospital, and to allow a patient living in a house, not overcrowded, and with fairly good sanitary conditions, to be treated in his own room. This is still the principle acted upon in Bombay City. District Officers have a discretion to leave patients at home if proper arrangements for isolation and treatment can be made. This privilege is, however, but very rarely granted. The rule is to remove all but moribund plague patients to hospital.

Policy adopted in Calcutta.

652C.
6587-88.
6445.
II., 532.

601. In Calcutta also, during the first outbreak, though two or three patients who had "good airy upstairs accommodation," were allowed to remain in their houses, the practice was to take patients to hospital. As in Bombay, great difficulty was encountered in removing the patients, and all sorts of devices were resorted to to prevent the discovery of cases. We are told that "there was great opposition, at one time." In consequence of the experience in the first outbreak, it was determined in the second outbreak to leave the sick, if they preferred it, in their own houses.

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* *See* Appendix IV.

602. In Karachi, after the first epidemic had reached its height, and generally in Policy generally adopted.
infected towns throughout India, the compulsory removal of plague patients to hospitals 11,108, 11,620–3;
has been insisted upon. 11,952.

603. This measure has been everywhere unpopular. The public have shown a vague Attitude of the people
fear and detestation of the Government Hospitals. They have misunderstood the object towards removal to hospital.
with which the Government has directed the removal of the sick to hospital. For
instance, there was in Bombay City a universal idea that the patients in the Municipal Mr. Snow's
Hospital were all operated on during life and dissected after death. "I know," says Report, paras. 7, 19.
Mr. Macdonald, who had large experience as a volunteer Plague Officer in one quarter 17,950.
of the City, "that those who recovered consider that their recovery was due to my
having spoken for them to the doctors and nurses, rather than to the great care both
doctors and nurses took of them." At Bandra the people thought they were going 18,574.
to be poisoned, and they objected altogether to go to hospital. So strongly did some
of them fear poison that in many instances hospital patients not only refused to take
medicine, but refused to take even food and drink. The people of the Sirohi State 9884–5.
objected, Captain Grant, I.M.S., told us, to being medically treated; "they objected to
our touching them." At Bangalore it was rumoured that the Government were 2628.
poisoning the people. Mr. Madhava Rao, the Plague Commissioner, speaking of the 3239.
concealment of cases and the flight of contacts to evade detection and removal to
hospitals and camps, says, that "these measures, in spite of every effort to popularize
them, were and are a source of horror and dread to the people."

604. The unreasoning terror of the people at the idea of going to hospital was Removal of mori-
increased owing to the numbers who died after they were taken there. In view of bund cases.
the great fatality of plague, and in view of the fact that many patients
were brought in in a moribund condition, the mortality at many of the Plague
Hospitals has unfortunately been very high. In Calcutta it was about 80 per cent.; 6550.
in the Arthur Road Hospital at Bombay, 71·44 per cent.; at Baroda, about 21,050.
71 per cent; at the Sassoon Hospital at Poona, 74·4 per cent.; at the hospital in 15,266, 12,896;
Bangalore City, 66·7 ; at the three hospitals in the Civil and Military Station at Banga- 25,024; III. 286.
lore, 63·4, 60·2, and 71·4 respectively. A large number of the people removed to the
hospital must have been *in extremis* or actually dead when they arrived there. At Calcutta 6551.
many people were taken to hospital in a dying state. At the principal Plague Hospital
in Bombay (the Arthur Road Hospital), about 38 per cent. of the deaths occurred 25,734.
within 24 hours of admission. In the Plague Hospitals at Baroda and Ankleshwar, the
deaths which occurred within 24 hours of admission numbered 143 and 61 out of a 15,266, 14,443.
total of 342 and 141 deaths respectively. We have already, in a preliminary report,
expressed the view that moribund patients should not be removed to hospital, and the
removal of moribund patients has been prohibited by the Government of India. It is,
however, extremely difficult for a Medical Officer to feel certain that a patient has no
chance of recovery. Even when a patient at his house looks fairly well he may be in
a moribund condition when he arrives at the hospital. It is for these reasons difficult,
under a system for the compulsory removal of sick persons to hospital, to guard against
the removal of persons who would reach the hospital in a dead or dying condition.

As, in his opinion, the evidence now in the possession of the Commission indicates that patients suffering from the bubonic, or the most frequent, form of plague become specially liable to communicate the disease to others a few hours before death, and patients suffering from the pneumonic form probably at all periods of the illness, and, further, as there are almost insuperable difficulties in determining that a patient is actually in a dying condition, the President considers that moribund patients should be removed to hospital wherever effective isolation in their houses is impossible, unless grave reasons of policy outweigh the serious risks that are otherwise incurred.

605. The wide-spread apprehension of the hospitals was one of the reasons which led to Concealment of
the habitual concealment of cases. It is impossible to say how far this result was due cases an effect of
to the fear of the removal of the sick person to hospital, and how far to the fear of fear of removal
other plague measures, especially the removal and segregation of the sick man's friends to hospital.
and relatives. We think that it must be attributed to both causes. At any rate in
large towns where plague measures were strict, the people concealed plague to such an
extent as to practically defeat the measures taken against it. In Bombay and Calcutta, 489, 6599,
as well as in other places, they carried plague-stricken persons from one house to 16,229–32.
another, and thus increased not only the number of infected houses but also the
uncertainty as to what houses were infected.

606. The fear of removal to hospital was most acute in the case of hospitals maintained Steps taken to
by Government or authorities identified with Government. Early in the history of the render removal to hospital as little

objectionable to the people as possible.

Mr. Snow's Report, p. 6.

Gen. Gatacre's Report, pp. 12–14. Sir James Campbell's Report, pp. 108–9.

II., 533.

epidemic in India attempts were made to render compulsory removal to hospital as little objectionable to the people as possible. The sick person was generally permitted to have with him one or two of his friends to take care of him. And since one of the objections to going to hospital was found to be a fear of treatment according to European methods, he was allowed to have native treatment if he preferred it. The establishment of private hospitals and hospitals maintained for the treatment of persons belonging only to particular classes or castes was encouraged. In October 1896, two non-Government hospitals for Hindus were opened in different parts of Bombay. At that time the terror of hospital life extended even to hospitals of this nature. But the next attempt produced better results. In December 1896 a Jain Hospital, a little later a Parsee Hospital, at the end of January a Hindu Hospital—all started by the leaders of the various communities for their fellow castemen—were opened, and they, and a private hospital started by the Bombay Port Trustees for their own employés, were all at work and doing excellent service before the Bombay Plague Committee was created. Subsequently, there was a great extension of this system of private hospitals. There were 28 of them while General Gatacre, and 36 while Sir James Campbell, was Chairman of the Committee; and both these officers are of opinion that the results were distinctly successful. In dealing with Orientals many intricate questions relating to caste and race habits, food, religious scruples, and similar matters arise, and they require very careful treatment. The establishment by the various communities of caste hospitals managed entirely by their own Medical Officers and staff, though supervised by the Government Medical Officer, was found in Bombay to help to allay the apprehensions of the people on these points. This was also the experience at almost all the places where the experiment was tried. But the antipathy to hospitals was not altogether removed even by the establishment of private hospitals. In particular at Calcutta private hospitals were not much used.

Compulsory removal to hospital not insisted on in certain places.

607. Such being the feeling of the people, the experiment has been tried in some places, notably at Calcutta and Mysore, of leaving it to the option of the people to go, or not to go, to hospital. The result was that in Calcutta, from 18th February 1899 to the end of August, only 103 went to hospital out of 1,638 patients, and in Mysore, from the beginning of the outbreak there in November 1898 up to 8th September 1899, only 312 out of 2,795. These results are not encouraging. Experience at these two places throws great doubt on the possibility of ever securing, on any system under which the people are allowed to exercise an option, the isolation in hospital of any substantial proportion of the sick. We must, therefore, look carefully at the results which have followed in places where there was little or no isolation of the sick. To give examples of places where the sick were not removed to hospital, and the total attack rate was very high, is unnecessary. Such places undoubtedly exist, just as places exist—Poona in the rains of 1899 appears to be one—where the rigorous removal to hospital of every patient that could be found did not save the people from an outbreak of extreme violence. The question really at issue is whether the remaining of the sick in the houses is, in every place, accompanied by a very high rate of attack in a town, or a very high rate of attack in individual houses. This question would appear to be answered by what happened at Mysore City and Calcutta in the second outbreak, in both of which places, as mentioned above, no measures of compulsory removal were adopted, and the great bulk of the sick have remained in their own homes.

Abandonment of compulsory removal to hospital in Mysore City not accompanied by high rate of attack.

25,031.

608. We will deal first with the facts relating to Mysore City. Inasmuch, as from the time when the outbreak in Mysore City began at the end of November 1898, down to the 8th September 1899, the number of deaths which actually occurred exceeded the normal mortality by 3,035, we may assume that this number approximately represents the number of deaths from plague that occurred. The number of cases of plague that occurred must have been considerably larger. Assuming that the plague mortality was as high as 75 per cent., there must have been at least 4,000 plague cases. Of these, only 312, as we have seen above, were brought into hospital. It is probable that we shall not be seriously over-estimating the number of plague cases treated in their own homes if we put them down at about 3,700. With regard to the number of houses in Mysore City in which more than one case of plague occurred, we are told by Mr. Cadell that up to the end of February 1899, only 119 houses in Mysore City had had more than one attack of plague in them, while in 76 of these there had been two attacks, and in 26 three attacks. In the remaining 17 the number of attacks had varied from four to ten, more than seven attacks having occurred in one house only.

Experience in Calcutta similar to that in Mysore City.

609. The experience at Calcutta was of much the same kind. From the time when Calcutta was declared to be infected in February 1899, up to the end of August, there were 1,638 reported cases of plague and 1,517 deaths. The total mortality during that interval was 13,017, as compared with a normal mortality of 11,842. We obtained from the special Health Officer at Calcutta, a report with regard to the effect of treating patients at home on the spread of the disease among the other occupants of the infected house, and among persons resident in the neighbourhood. He gave the following opinion :—" It is difficult to separate these questions, as bustee huts II. 537. communicate so with one another that the distinction between a room and a separate house is not marked. I am of opinion that the results of the present measures do not suggest that they have tended in any way to cause the spread of plague; in fact, the indications are the other way. Although we still hear of cases chiefly through the death reports, I am of opinion that, with more stringent measures, there would have been a far more systematic suppression of cases, by disposing of the dead anyhow, and by giving false information. As well, there would have been an active opposition to disinfection and to moving patients, and although a few more cases would have been able to be shown as 'died in hospital,' the disinfection of places where plague patients had died and their vacation would have been less, and the probability of disease spreading greater, not taking into account the scare and dislocation of trade that would have been caused and the race animosities aroused. I would here point out that disinfection is not confined to plague cases, but is performed after nearly every death from fever. After death has taken place, the fact that a death has occurred is willingly volunteered, and disinfection is even sought for by the neighbours." As to the effect of this policy on other residents of the houses in which the sick persons were left, he said that, as a rule, many cases had not occurred in the same house. In some instances, however, the number attacked in individual houses had been large. These facts show clearly that plague did not spread in Calcutta in the manner in which it has spread in other large towns, and that, speaking generally, there was no great concealment of plague.

Judged merely by the results set forth above, without taking any other circumstances into consideration, the policy of permitting the sick to be treated in their own houses does not appear, in the case of Calcutta or Mysore City, to have led to a violent outbreak.

Conclusions regarding removal to hospital.

610. We may now proceed to sum up our conclusions on this difficult question of the expediency of the compulsory removal of all plague cases to hospital. From the experience of the past, it seems to us to be clear that where the Government has been able to provide a staff sufficiently strong to defeat concealment, the compulsory removal to hospital has been a measure which has justified itself. It has, however, in only a few outbreaks been possible to provide a sufficiently strong staff. In most places, and particularly in the large towns, compulsory removal to hospital has led to great concealment of cases, with the result that infected houses have escaped disinfection. It has further led to the removal of the sick from one house to another, and has thus directly contributed to the spread of plague. Further, owing to the prevalent fear of hospitals, compulsory removal to hospitals of sick persons has, in some cases, had a prejudicial effect on the person so removed, particularly when he has been hovering between life and death. Therefore, where the staff available has not been sufficiently strong to secure the removal of all, or, at any rate, of the large bulk of plague patients to hospital, the measure has not been justified by the results. Since then the measure is, in many cases, inexpedient, the possibility of the extent to which people will bring plague patients into hospital on a voluntary system becomes a question for serious consideration. Experience hitherto gained shows that the great majority of people will not go to hospital unless they are compelled to do so. The aversion to hospitals may be to some extent lessened by encouraging the establishment of private and caste hospitals, by locating hospitals near to infected quarters so as to lessen as far as possible the distance the plague patient has to be carried, by limiting the size of hospitals and paying special attention to the provision of medical attendants and nurses and of ample and comfortable accommodation for patients, by providing accommodation close to each hospital for the friends of patients, and by permitting at least two friends to be in attendance on each patient so that the patient may never be left alone. We think, however, that it cannot be anticipated that, for the present at all events, any steps of this nature will have any very material effect on the attitude of the people as regards removal to hospital. In the great majority of cases they will evade going to hospital as far as they possibly can.

In most cases the choice would thus seem to lie between attempts to remove the sick compulsorily to hospital and treating them in their houses. We have, therefore, to consider what results may be anticipated to follow if the sick are left in their houses. There can be no doubt that in most cases this will tend to the spread of plague. But the experience in Mysore City and Calcutta—an experience, however, which cannot be generalised from—shows that the leaving of the sick in their houses is not everywhere followed by a very serious spread of plague.

To sum up, it appears that the adoption of a policy of removal to hospital, if it is unsuccessful, will, as we have seen above, carry evils in its train. On the other hand, evils will result from abstaining from all attempt to remove plague patients to hospital. The question as to which policy most contributes to the spread of plague is one that must be answered with reference to the particular circumstances of each place. In dealing with imported cases, or with an outbreak in a small place upon which it is possible to concentrate a sufficiently strong establishment, there can, in our opinion, be no question that the first measure to adopt is the compulsory removal of the sick to hospital. In dealing with early indigenous cases the same policy may be advisable. But if this policy prove unsuccessful in a large place a point may soon be reached where the authorities will not succeed in getting the bulk of the cases. When this point is reached, the fact must be faced that the evils of leaving the sick in their houses are being incurred, and that the attempt to remove to hospital may be superadding to these the evils that result from carrying about sick persons from house to house. At this stage the less the sick are interfered with the better. It appears to us that all that can then be done is to endeavour to palliate the evils that result from leaving people in their houses by arranging for continual visitation of the sick at home, the frequent disinfection of the infected room, and the encouragement of inoculation among persons left in the houses with the sick.

III.(2.)—*Segregation of Contacts.*

Grounds upon which segregation has been adopted.

611. The segregation of persons who have been in immediate contact with plague patients is a measure which has been adopted on the general ground that it is necessary to keep, for a period at least as long as the period of incubation, under continuous medical observation those who, there is reason to believe, may have contracted plague. Among Orientals of the classes specially affected by plague, the only effective way of carrying this out is to place them in a segregation camp. An incidental benefit claimed for segregation in camps is that it ensures the vacation of plague-infected houses until there has been time to disinfect the buildings, and so operates in the direction of protecting the contacts themselves from the risk of infection from these houses.

Conditions essential to success of a system of segregation.

To make segregation effective in protecting the community, the great majority, at all events, of the contacts must be found out and detained for the maximum period of incubation; and those in contact with each successive case of plague that occurs in the segregation camp must be detained for a further period of the same length. All clothing must be effectually disinfected on entry into the camp, and, if plague cases have occurred within the camp since the date of entry, at the time of departure also. Success depends on the active co-operation of the people, combined with the maintenance of large establishments. The staff available to carry out the segregation of contacts must be very strong relatively to the number of cases that occur. Opposition or indifference on the part of the people, and venality on the part of the guards, are difficulties in the way of effective measures for segregating contacts which have always to be reckoned with.

Attitude of the people towards segregation: measure unpopular.

612. Although the segregation of the healthy inmates of infected houses may not generally have been so distasteful to the people as the isolation of the sick, there is no question that it has been invariably resented by the residents in towns, and that in particular places the popular feeling against it has been very deep-rooted. The people dislike the confinement of the segregation camps. They do not like being removed from their houses, and from their relations and friends. They are put to great trouble in removing their goods and chattels, and they are exposed to the danger of being deprived of property by unscrupulous underlings during the process of removal. They do not like being absent when their houses are disinfected. Sometimes they object that the huts provided for them are insecure and liable to catch fire. Sometimes they object to go to the segregation camp because it involves a second move after only ten days. The well-to-do and those who are members of the higher castes object to being sent to the same camp as the poor and low classes. Probably many other reasons, which have a very real effect on the oriental mind,

though they would not all appeal to a European, have been operative along with the reasons specified above in creating among the people a very wide-spread fear of the compulsory segregation of contacts. In many cases contacts have run away rather than submit to it; in others they have stayed in the town and systematically evaded it.

Fear of segregation the cause of panic and concealment of cases.
6540–6544.
2622.
3282.
3480.

613. The fear of segregation led to a great exodus from Calcutta before the measure was put into force. The same thing happened at Bangalore City and the Civil and Military Station. Colonel Robertson, speaking of Bangalore Civil and Military Station. said, "the fear of segregation and our measures is such as to render the segregation measures practically useless." Mr. Madhava Rao said of Bangalore City, "From the commencement, the people manifested the utmost abhorrence to compulsory segregation, and great difficulty was experienced in effecting it." Lieut.-Col. Benson, I.M.S., also speaking of Bangalore City, said: "From the very commencement it was clear that compulsory segregation as a measure for arresting the disease was objectionable to the people, and large and numerous meetings protesting against it were held. Concealment of cases occurred almost from the commencement, but it was not until the epidemic assumed greater proportions that they began to dispose of their dead by throwing them out of their houses at night, &c.; 15 dead bodies were found in locked-up houses, and no less than 392 unclaimed bodies were found and disposed of." In Sholapur, "as soon as a case occurred in a house, all the inmates at once fled to escape infection and segregation." The dread of segregation made people run away from Nasik. Writing after an experience of two outbreaks in Karachi, Mr. Giles, the Commissioner in Sind, thus referred to the question of the unpopularity of segregation camps; "the Plague Committee, with the Acting Commissioner's approval, passed an order permitting people to leave the city with their sick, and without detention in the regular segregation camp, provided that they notified the sickness. The result has been that the one great and overwhelming dread which ever abided in the minds of the people, namely, the dread of the government segregation camp, was removed, and with it the occasion for scattering like rabbits, whenever a case occurred, into houses and other streets, carrying infection with them, ended also." Other instances could be cited of the agitation produced in the public mind by the fear of segregation, but it is unnecessary to quote them.

20,237.
13,833.
Paras. 17 and 18 of Report of 31 January 1899 to the Government of Bombay.

Contacts flying from segregation carry infection to uninfected places.

614. The result of the feelings entertained by the people towards segregation was clearly shown not only in the dispersal of contacts from infected into uninfected places at a distance, but also from the infected parts of towns into uninfected parts. A large proportion of plague cases come to the notice of the authorities when the patient is either dead or moribund. The contacts have had an opportunity of escaping before the case is discovered, and the testimony of all witnesses who were able to speak from personal experience is that many of them succeeded in doing so. This fact is proved beyond a doubt by the statistics at the different segregation camps.

History of segregation in Bombay City.
Mr. Snow's Report, p. 18.
Gen. Gatacre's Report, p. 5.

615. Segregation of contacts was not attempted in the earliest stages of the outbreak in Bombay City when the operations against the plague were under the control of the Municipal authorities. The vacation of infected rooms, for the benefit of the contacts, was regarded by those authorities as more important than the detention of the contacts in camp, for the benefit of the community. One of the measures which General Gatacre's Committee was intended to take up was a gradual introduction of an organisation for the segregation of the people living in the same room with, or in close attendance on, a person found to have the plague. The Committee were accordingly authorised to place the inmates of an infected building in segregation for a period not exceeding ten days. There was, however, no organised system of camps for the segregation of contacts under General Gatacre's Committee. Directly a plague patient was removed to hospital his family was required to vacate his room, and disinfection commenced at once. The majority of the contacts were allowed to find fresh accommodation where they pleased. Only a certain number of the relatives of patients attended them to hospital and were segregated in its neighbourhood. The Committee under Sir James Campbell did not issue rules for the segregation of contacts till the beginning of December 1897. These rules provided that "in large chawls, unless several attacks took place, it would not usually be necessary to segregate the inmates of more than two or three rooms. In the case of large private houses contacts might be segregated either in another part of the same house, or in an outbuilding in the same enclosure. Provision was also made that, when plague officers admitted its fitness, contacts might be isolated in a private segregation camp; that cases occurring in an eating-house would not necessitate the other inmates being made contacts; that leniency should be shown

Sir James Campbell's Report, pp. 12, 13.

to goldsmiths, handloom weavers, and other craftsmen who work in their houses. The detention of contacts was to be limited to ten days and might be reduced to seven, and a modified system of surveillance was sanctioned." Rations were provided in the public segregation camps, and in the case of these camps the bread-winner, whether man or woman, was allowed to go to work, provided the night was spent in camp. All clothes were disinfected at the camp, and suspicious contacts were, on arrival at the camp, kept separate until they either developed plague and were sent to the Plague Hospital, or until the fall of their temperatures made it safe for them to mix with the other inmates of the camp.

10,953. The segregation of contacts does not appear to have been very strictly carried out during the second outbreak at Bombay. Major Ross said in his evidence, "To a modified extent they were taken to contact camps—one or two of them—we were not allowed in Bombay to take the whole of the contacts." He estimated the contacts taken to camp 4029-33. at about one-fifth of the actual number of contacts. Major Bannerman, I.M.S., on an examination of the figures for 15 days in March 1898, came to the conclusion that only one contact was taken to camp for every four cases of plague. And Captain Bingley, 8258. who succeeded Major Ross, informed us that "if a family was fairly respectable and the place was not overcrowded, and there was good accommodation in a house, the contacts were allowed to be segregated in that house, the district officer keeping them under observation and visiting them every day. The removal to contact camps was reserved for cases of extreme overcrowding, and of very poor patients."

1354. During the third outbreak the measure has been still further modified, so as to be as little irksome as possible to the people affected by it. "The contacts," said Mr. Du Boulay, "are the only people whom we treat at all strictly, and we have very much modified regulations in regard to them. We merely tell them that they have to come back to camp at night. We tell them that they are not to sleep out. We have not found that that has resulted in many of them running away." And again, "We have not 25,629. what you call a contact camp. I mean the restrictions are almost entirely abolished. All we can say is that 'you must bring your cooking pots to camp, and you must live there.' They can go to their work, but they are expected to sleep there; they do not go to their own houses."

It is thus apparent that the only effectual system for the segregation of contacts, viz., that under which a contact is continuously detained under observation in camp for at least the full period of incubation, was not at any period strictly carried out in the City of Bombay.

Segregation in places other than Bombay City.

616. In the infected towns in the interior of the Bombay Presidency, such, for instance, as Poona, the segregation of contacts was attempted at an earlier date than it was at Bombay City, and the manner in which it was carried out in them was generally stricter. At Poona, during the first outbreak, after an initial period during which the policy was to allow the contacts to pursue their ordinary avocations in the city during the daytime, segregation was strictly enforced. Strict regulations regarding segregation were also in force at other places, among them at the big towns of Surat (during the second outbreak), Karachi (during the latter part of the first and the earlier part of the second outbreak), Bangalore City, and the Civil and Military Station of Bangalore, as well as in the infected places in the Saharanpur District of the North-Western Provinces, and in the infected villages in the Punjab, Sind, the Baroda and Cutch States, and elsewhere.

Mr. Rand's Report, p. 23.

24,417-9
11,157-9, 3261,
2576, 9331-7,
10,057, 12,027,
13,377 13,440-1,
14,619.

Modifications adopted to relax the strictness of segregation.

617. As experience was gained it was often found necessary to modify the strictness of the regulations for segregation. Thus in the later stages of the second outbreak in 21,694. Poona the system of the strict segregation of contacts in a segregation camp was definitely abandoned, and an arrangement, under which people were allowed out during the day but had to report themselves at night and to answer a roll-call in the morning, was substituted for it. When plague again became indigenous in Poona, in February 21,817-20. 1899, contacts were kept under observation for ten days; it was incumbent on them to sleep in the camp, but during the day they were given their liberty, and as soon as the disinfection of the house, which was commenced immediately after the removal of the patient, had been completed, they were permitted to re-occupy it during the day-time. Later on a further concession was made by allowing the contacts after sleeping three nights in camp to complete the period of observation in their own houses.

11,674-75.
11,822.
11,894.

In Karachi again, the rule prohibiting contacts from re-entering the town was relaxed during the second outbreak, so as to allow people who had to go to offices within the town to leave camp during the day for business purposes. The subsequent

adoption of a system of voluntary camps, towards the close of the second outbreak 11,258-65.
and during the third outbreak, led to a general relaxation of the system of
segregation.

A similar relaxation of the rules at Bangalore Civil and Military Station, so as to 2670.
permit the people to go out to earn their living, led, it was found, to the disappearance
of those who should have returned to the camp, and the concession had to be
withdrawn.

Later on it was determined in some places not to enforce strict segregation in the
case of persons who had been inoculated. inasmuch as it did not seem likely that they
would develop plague. At Calcutta, for example, when the first outbreak began, 6537.
arrangements were made to exempt households, the whole of whom had been inoculated,
from segregation on the occurrence of plague among them. Similar concessions were
made in Bangalore City and the Civil and Military Station of Bangalore. The 2637-8.
inoculated contacts were allowed to remain with the patient if he was living in 2662-4. 3292.
a house of the better class, otherwise they were removed from the house but not
required to go to the segregation camp. In Hubli the concession of not being 19,826-28.
taken to the segregation camp was given only to twice inoculated contacts, and 23,375.
they were allowed to re-occupy the house after it had been disinfected.

A further development at certain places has been the practical abandonment of the
attempt to segregate contacts. This was in some places due, in the first instance, to
the impossibility of carrying out the measure owing to climatic or physical difficulties.
Segregation had to be abandoned during the height of the rainy season at certain places 22,116, 22,176.
in the Bombay Presidency such as Bhiwandi and Kalyan in the Thana district and the 19,660.
city of Belgaum. The segregation of contacts was nominally one of the measures 22,807-8.
adopted in the outbreak of 1898 at Calcutta, but it was not actually enforced after 6534-35. 6591-95.
the first case or two. When a patient was taken to hospital the people in the
infected room were required to leave it and it was thoroughly disinfected. They
were permitted to go where they liked. Calcutta is so closely surrounded by swamps
that the area necessary for segregation, had plague assumed large proportions,
could not have been found during the rains, and the rains were close at hand when
plague made its appearance. In the outbreak of 1899, the segregation of contacts II. 532.
was in Calcutta designedly abandoned. The same policy was followed in the city of 24,956-62.
Mysore.

618. The average number of contacts to each plague case was estimated by some Statistics regarding
witnesses at about four, but one witness estimated it at seven or eight. The figures segregation camps.
ascertained at the Census of 1891 give the average number of persons per house at 493.
5·4 over India. In Bombay, where certain classes habitually live in large Mr. Baines' Census Report for 1891,
lodging-houses, the average number of persons per house is calculated at 14·4. p. 57.
Probably four contacts to each plague case would be the average number in rural
tracts. In the larger towns the number is certainly much higher. As a matter of
fact, nothing like these numbers were actually taken to the segregation camps.

In Bombay, the maximum number of contacts in the segregation camp at any one Sir James
time under Sir James Campbell's Committee was 1,061 (on March 7th, 1898). The Campbell's **Report**,
average daily number of attacks was high, and sometimes, as in February, exceeded p. 13.
160. Thus, as stated in Sir James Campbell's report, "even after adding the number
sent to hospital as attendants, this falls far short of the total number of contacts which
the average daily plague cases in January and February should have yielded." The
number admitted to the chief Bombay contact camp at Wari Bandar between January 1st 20,442.
and April 30th, 1898, was 5,790. The recorded plague cases in this interval were
15,053, and the real number was much larger.

In Karachi, during the second outbreak, the total number of contacts segregated
between 25th March and 11th December 1898, was 10,215. There were in this interval 11,660.
about 3,000 ascertained cases of plague. The maximum number of contacts segre- 11,628.
gated in any one week was 934, but the recorded cases of plague were in some weeks
over 500.

In six months during the second outbreak of plague in Surat, 6,551 persons 15,948.
were segregated as contacts. The recorded plague cases during this period were
1,672, so that nearly four contacts were segregated to every ascertained case of
plague. But there were in Surat two reasons for what is, at first sight, a more
successful result than was attained in other large towns. In the first place, the neigh- 16,004.
bours of a person suffering from plague were under certain circumstances liable to
be segregated in the contact camp, and in the second place the inmates of every house in 15,715.
which an uncertificated death took place were all segregated. There were thus in the
contact camp a number of persons who were not known to have been actually in contact
with a plague case.

The segregation of contacts was systematicaly enforced in Poona, from March 13th,
Mr Rand's Report and Appendices. 1897. Up to May 20th, 1897, 4,058 persons were segregated, and the reported
plague cases during this interval were 1,447, so that even at Poona, where the
measures taken for the detection of cases and the segregation of contacts were more
vigorously enforced than anywhere else, and where troops were used for the detection
of cases, the proportion of contacts, which the authorities were able to find, was not
21,635. high. In the second outbreak at Poona there were 4,644 reported cases of plague
between August 1897 and the end of February 1898. The number of contacts
21,834. segregated was 13,213, which represents a very slight improvement on the figures
for the previous outbreak. The results were better during the third outbreak, when,
as already explained, the system of the compulsory detention of contacts was replaced
by one which was practically a system of surveillance. In his evidence, given on
March 20th last, Major Reade was able to tell us that the number of contacts over
25,827. whom supervision had been exercised during the third outbreak was 2,013, or nearly
seven contacts to each of the 290 ascertained cases of plague.

Para , above, 25,028. In Bangalore City, the mortality from plague between the middle of August 1897
and the end of March 1899 must have been about 6,300. The number of admissions
Para. , above, 25,028. to the contact camp during this period was 3,960. In the Civil and Military Station of
Bangalore the number of deaths from plague between the beginning of the outbreak
in the middle of September 1898 and its close in March 1899 was probably over 5,200.
The number of admissions to the two segregation camps was only 2,414.

The results in Poona Cantonment and at Hardwar and the infected places in its
neighbourhood are better. But in both cases the conditions were most favourable
21,268. to success. In the Poona Cantonment a very large force of soldiers was employed,
and the population dealt with was small and accustomed to semi-military discipline.
9178, 9213, 9230–1, 9244. At Hardwar and the neighbouring places, again, the population to be dealt with
was not large, some influential sections of the community were on the side of the
authorities, the physical conditions of the country rendered evasion of the regulations
less easy than it was elsewhere, and the establishments employed were, relatively
to the population to be dealt with, extremely strong. The results in the Punjab
10,272, 10,389. were also fairly good, the plague there being confined to a limited area, and the
establishment employed in dealing with it being strong. At Ankleshwar, where the
14,214–5. population of 10,000 was reduced to 4,000 during the outbreak of plague, 1,627 contacts
were secured to 331 recorded cases of plague. The fact that it was at these
places possible to make the segregation of contacts an effective measure, does
not, we think, support the view that it could be efficiently carried on under less
favourable circumstances among a more unwieldy population and by an establishment
of less comparative strength. And the fact remains that, in the large towns in which
the policy of segregation was adopted, the number of contacts who were secured
did not at all correspond with the number exposed to infection. The best results were
those obtained during the latest outbreak at Poona, when the conditions of segregation
were materially modified, and the system, except for the first three days, was, in fact,
converted into one of surveillance.

Plague in segregation camps. 619. In no place has there been a serious outbreak of plague in a segregation camp.
The proportion of segregated contacts who have developed plague in camp has varied
25,028. considerably. In Bangalore City, 238 (6 per cent.) out of 3,960 contacts developed plague;
23,935. in the main segregation camp at Sholapur, 101 (7 per cent.) out of 1,421; in Mysore City,
25,028. where the occupants of the camp had all gone to it voluntarily, 27 (6 per cent.) out of
1902. 452; and at Dharwar, 50 (5·3 per cent.) out of 927 contacts. In the latter place,
27 persons out of 34 who accompanied plague patients from the contact camp to the
I. 223. hospital developed plague in the hospital. At Hinganghat, 15 persons (5 per cent.)
out of 306 segregated developed plague. In other instances the attacks among
contacts in segregation camps were even fewer. At Jawalapur the number attacked
9178. was 24 (3·3 per cent.) out of 717; at the Wari Bandar camp in Bombay between
20,442. January 1st and April 30th, 1898, 148 (2·5 per cent.) out of 5,790; in Karachi,
11,671–72. between March 25th and December 11th, 1898, 169 (1·6 per cent.) out of 10,215; and
25,028. in Bangalore Civil and Military Station, 76 (3 per cent.) out of 2,414. At Wardha,
I. 224. 100 persons were segregated, and one developed plague. At Poona, during the
Mr. Rand's Report. first outbreak, 53 (1·3 per cent.) out of 4,063 persons segregated developed
21,834. plague; during the second outbreak, 146 (1·1 per cent.) out of 13,213; and in the
25,827. third outbreak, up to the middle of March, 15 (·7 per cent.) out of 2,013. In Surat,
6,551 contacts were segregated between November 5th, 1897, and May 7th, 1898,
15,948. of whom 36 (·5) developed plague. The relatively small proportion of attacks of plague
in the camps at Surat is to some extent accounted for by the fact that a number of the
inmates would not have been treated as contacts elsewhere. At Cutch Mandvi no

record of cases among the contacts was kept during the first outbreak. In the second 13,390–1.
outbreak there were only three attacks in the general contact camp, in which it is 13,437–9.
estimated that 1,000 to 1,200 persons were accommodated. At other places from 12,573.
which details as to the number of contacts in the camps are not given the number 12,648.
of contacts attacked in camp is small, *e.g.*, Kotri (one case in the first, and eight in the 13,722. 8797.
second outbreak), Porbandar (five cases), Kankhal (four cases), Khari, near Baadra 18,936.
(no cases), and Hyderabad, in Sind (19 cases). 18,125.

The percentage of attacks among the contacts was not in any case very serious, and the figures do not justify the conclusion that in an outbreak the contacts from a house in which a case of plague has occurred must be regarded, from the point of view of the protection of the rest of the community, as so dangerous that they ought to be compulsorily removed to a segregation camp.

Segregation in rural areas.

620. The remarks which we have made refer mainly to the segregation of contacts as it has been carried out in the towns. When the area of infection is restricted, as in the single village of Khandraoni in the Gwalior State, and the villages infected in the Saharunpur district, or when, as in the area infected in the Punjab, it is possible, as an emergency measure, to employ large establishments among a considerable number of affected villages in close proximity to one another, it will be possible to carry out the segregation of contacts in rural areas in an effective way. The difficulty which exists in the towns of finding and getting the contacts into camp does not exist in the villages. It is at a subsequent stage that difficulties arise in carrying out the segregation of contacts in rural areas, viz., when the people are in camp and those who are being treated as contacts desire to mix with the other residents of the village in camp. This can be prevented only by strict supervision, and such supervision is impossible when the number of villages affected is as large as it has been in many parts of Southern India, and particularly in the Sholapur, Poona, Surat, Dharwar, Satara, and Belgaum districts and in the Mysore, Hyderabad, and Kolhapur States. Although contacts were
segregated in some parts of the rural areas infected in Western and Southern India, 15,108.
it was in others found to be a hopeless task to attempt to keep the sick and those who 18,396.
had been specially exposed to infection apart from the rest of the community. The 1660–3. 3333.
majority of those who have been engaged on the work of supervising plague measures 22,743.
over a number of villages recognised that they could not effectively control the 23,541–42.
movements of contacts in the camps, and with this we cordially agree.

Conclusions as to value of segregation from the point of view of protection of community generally.

621. Our conclusions as to the value of the segregation of contacts, regarded as a measure for the protection of the community generally, are as follows :—

(1.) That where the infection is confined to so small an area that contacts can be accurately known, and establishments can be provided sufficient to secure the detention of every contact, the measure, if it is combined with the disinfection of the infected house, is a most efficient one, in rural as well as urban areas. It may be of the greatest value in dealing with imported cases where there is no indigenous plague.

(2.) That in urban areas where the infection of plague is widespread, segregation can easily be evaded, even where large establishments are kept up. In these circumstances it has, as a matter of fact, in consequence of its extreme unpopularity, been so largely evaded as to be quite ineffective for the protection of the community. Where the infection of plague is widespread in a city, it would, therefore, be better not to make any attempt to segregate contacts.

(3.) That in rural areas it is useless to attempt to segregate contacts when the infection is present in more than a few villages, since it is impossible to provide the establishments necessary to prevent the contacts from mixing in camp with the rest of the population.

III.(3.)—*Evacuation.*

"Evacuation."

622. We have dealt with the removal to hospital of those suffering from plague, and with the segregation of those who, though healthy, have been specially exposed to infection. We will now pass on to the emptying of all or some of the houses in an infected town or village, with the idea that they should not be occupied as dwelling-houses until it is believed that they can again be occupied without risk of infection. The practice was to establish the people thus removed in temporary camps in the open country. This measure is generally known in India under the name of "evacuation." A distinction is drawn between "partial evacuation," or the emptying and shutting up

of individual houses or particular groups of houses, and "total evacuation," or the emptying and shutting up of all the houses in an infected place.

Essentials of ideal evacuation.

9263–5, 9281–3, 10,297–9, 10,363, 10,616–9, 12 107–19, 13,452, 17,611, 18,451–2, 18,582–4, 18,764, 19,639–41, 20,234-8, 21,639, 21,667, 22,085, 22,288–9, 22,599–607, 22,737, 23,169–74, 23,536–43, 23,589, 24.193–200, 24,314.

There can be no question of the theoretical advantages of effectual evacuation. It must be a good thing to remove people from infected houses or infected quarters, into uninfected surroundings. The question that has to be considered is how the measure works in practice. For to make evacuation thoroughly effective, certain conditions, which are not always easy of attainment, are required. The people should all be got out promptly; their effects should all be disinfected; each new case should be immediately isolated; suitable accommodation should be available; the people should be effectually prevented from visiting, or sleeping in, the infected houses until either the houses shall have been disinfected or until sufficient time shall have elapsed for the infection to disappear; and, lastly, the people should be prevented from scattering and spreading the infection in the neighbourhood. If it were possible to carry out evacuation with all these safeguards, it would, by the early extinction of the infection, benefit not only the inhabitants of the place actually infected, but also indirectly those of neighbouring places. On the other hand, the less perfectly the precautions can be carried out, the greater will be the danger, not only that the outbreak will continue in the infected place, but also that refugees may convey infection to other places.

Extent to which evacuation has been carried out in practice.

623. Evacuation, total or partial, has been one of the principal measures adopted at almost every plague-infected place.

6580, 6591–5. 11–13, 1345.

In Calcutta, however, the evicted residents merely transferred themselves to other houses. And in Bombay City evacuation has not, during any stage of the epidemic, been attempted on a large scale. The circumstances of these two big cities, the number, character, and employment of their population, and the absence in their immediate neighbourhood of suitable and sufficient open spaces for the accommodation of people removed from their houses, combine to render the evacuation of any considerable number of houses impossible.

5, 11, 1645, 1710, 3232, 3753–6, 4123–7, 4964–73, 4992, 4999, 9036, 9090–9113, 9173–8, 9276–8, 9821–2, 10,230–5, 10,921, 11,219–23, 13,453, 13,751, 13.790–6, 14,041, 14,613, 15,486–91, 15,883, 16,929–44, 18,070–5, 18,782, 20,231–3, 22,297, 22,596–8, 22,737–42, 23,241–3, 24,234, 24,253–5, 24,430–1, 24,545.

The results of evacuation must therefore be looked for in the towns and villages of the interior. We would first observe that the practice in towns has, generally speaking, differed from that in the villages. In villages, inasmuch as the population is comparatively small and compact, it has been the general custom, when once evacuation has been decided on, to resort at once to total evacuation It has been otherwise in the towns. There it has often been the practice in the earliest stages of an outbreak to evacuate only the infected house or houses. The authorities frequently waited a little time to see whether the vacation of the infected house or houses alone—by the removal of the sick to hospital and the contacts into segregation camp—would be sufficient to avert plague from the rest of the inhabitants. This, however, was rarely sufficient. As a rule cases kept cropping up in fresh houses. The evacuation of the neighbouring houses was then resorted to. This partial evacuation, though it has no doubt in many cases delayed the progress of the disease, has rarely succeeded in altogether preventing the spread of plague in a town. In a few instances partial evacuation apparently did succeed. These were, so far as we know, either cases where plague was confined to some detached part of the town, or cases where very few people were affected. In the end it was found necessary in a number of the towns, to make the evacuation total. Such total evacuation was resorted to, not only in the case of the smaller towns, but also in the case of two of the larger towns in the Bombay Presidency. These were Sholapur with a population of 62,000, and Ahmednagar with a population of 40 000. We are told that the whole of the residents of Baroda also (population 112,000) were removed from their houses. They do indeed appear to have been removed; but, judging from the extent to which business was being carried on in the town, they do not appear to have been effectively kept out of their houses.

Attitude of the people towards evacuation.

9912, 18,996, 10,239.

3321, 4970, 5007, 22,637–9, 23,675–6.

3413, 4161, 5462–3.

5455–6, 22,092, 22,622–3, 22,986.

3303, 12,086, 15,494, 22,089.

624 There was often difficulty, especially in the early stages of the epidemic, in getting the people to move out quickly from their houses. They hesitated to face the extremes of temperature at the different seasons, and the downpours of rain, which affect them more in their huts than in their houses. They were apprehensive of the safety of property left in their houses, and did not like to be parted from their goods and chattels. The Muhammadans were found more difficult to deal with than the Hindus, because of the seclusion of their females. The townspeople were more difficult to move than the inhabitants of the villages; and in the villages the shopkeepers, weavers, and persons engaged in industrial occupations were more difficult to move than the ordinary agriculturist. The residents of villages, in some instances, moved out of their own accord. These instances became more numerous as the people became

better acquainted with plague. Sir Andrew Wingate, when asked whether there was 9. much difficulty in inducing the villagers to go out, replied that "there is no difficulty now. I got a report only last week of a village in the Nasik district in which there had been a good many deaths of rats, and the people of their own accord immediately turned entirely out of the village. The Collector sent down two officers to enquire. The people said they had fever. The officers enquired very carefully into it, but could not find a trace of plague. But the people had all gone out on account of the rats and insisted on remaining out. In the villages in the Thana district, for instance, they go out immediately before any officer goes near them. In all our trained districts, as we call them, where they have been through the epidemic and have seen the wonderful effects of evacuation, there is no opposition at all. Down in the Dharwar and Belgaum country, where they have not had any evacuation experience (this is their first year), I daresay they do not turn out quite so quickly. These districts usually have very late rains, and some villages have been turned out once or twice, and villagers have had to go back again owing to heavy rain coming on. It is a black-soil country, and heavy rain necessitates a return to their houses. Each time they have gone back they have got plague again. I think very shortly down there we shall have no trouble about evacuation." This is what was foreseen by Surgeon-General Planck, who, speaking from his large experience of Kumaun and Garhwal, where plague is endemic, and where the people voluntarily evacuate their villages, said 26,575. "I think you will find that when plague becomes well-known in the plains of India the people will flee out of their houses of their own accord." Where the camps were, as we shall see was sometimes the case, maintained by Government and supervised by 15,914. officials, the people were less ready to go into them than where the camps were private camps, under less official supervision. In the worst infected tracts of country, establishments sufficient to exercise sustained control over the village camps could not be provided. The people were practically left to manage their own affairs in their camps with the assistance of the village officers.

Treatment of the evicted people.
1611, 1652, 2550, 3758–69, 6121–3, 8273, 9169, 9178–9, 9334–41, 11,319–25, 11,433, 12,770–6, 13,083–8, 13,163–5, 13,377–83, 13,423, 13,801–11, 14,421, 14,632, 15,502–3, 15,913–4, 16,016, 18,074–6, 20,231, 24,419, 24,554–62. Mr. Snow's Report, p. 18; 15,484, 24,563–4.

625. The treatment of the people after being removed from their houses varied at different places. In some cases they were located entirely in camps provided by the authorities; in others, some lived in camps provided by the authorities, and others were permitted to reside in camps provided by themselves. Speaking generally, it may be said that the Government or the Municipal authorities provided the huts for the population removed from the towns, and that the villagers provided their own huts. But a portion of the huts required for the population of a town was sometimes provided by private individuals, and in some of the villages huts were provided by Government. In a few cases, as, for instance, at Bombay, Broach, and Jalgaon, large employers of labour provided camps for the occupation of those in their employ. The life of the people while out in camp varied chiefly with the amount of control that was exercised over them. In the best managed camps a Superintendent was appointed to be in general charge. Arrangements to prevent the people from running away were made by guarding the camp with police, and having a daily roll call. In order to ensure the prompt detection of cases, and the isolation of the sick, Hospital Assistants inspected the people once or twice a day. All cases of plague, or suspected cases, were as they occurred removed to hospital or to a separate shed for observation, and the hut in which the sick person was found was burnt. Endeavours were made to keep the people out of the infected village by placing a guard over it, and by locking or sealing the houses. Where the place evacuated was a commercial town, the arrangements for keeping the people under control were sometimes relaxed, so as to permit the business men, weavers, mill-hands, &c., to go to their shops, offices, and employments during the day on condition that they returned to camp at night. The same standard of supervision was not maintained everywhere. There were different degrees of strictness at different places, and in many of the village camps where the control over the people was slight, the people were practically at liberty to scatter themselves over the country, and to carry plague about with them.

Period for which evicted people kept in camp.
10, 2141, 2580–2, 5451, 5926, 8301, 10,054, 10,266–70, 10,567–70, 10,929, 10,957, 12,033–4, 12,791, 13,134, 13,456, 14,687.

626. The length of time that the people have been kept out in camp before being allowed to re-occupy their houses has, of course, depended upon circumstances. The general principle was, that they should not be allowed back until it was believed that, not only they themselves, but also their houses, were free from infection. But if the monsoon was close at hand, or if any great storm occurred, or if the accommodation for them was very limited and was required for other people, then—whether the danger of infection appeared to be over or not—they had to be permitted to return. In large

cities like Bombay and Poona, where measures of chemical disinfection were applied to the houses, the people were often allowed back in 10 days, or even sooner. At Bangalore the people were re-admitted to their houses as soon as these were disinfected. In the Punjab and the Palanpur State, on the other hand, they were kept out for at least three weeks after the last case, and sometimes for a month. In the Bombay Presidency and the Hyderabad State the people were not allowed to return to their villages until at least a month after the date of the last case; and a further condition, which was generally insisted on, was that, unless a house had been chemically disinfected, it should not be re-occupied till two or three months after its vacation.

Evacuation with necessary safeguards impossible in certain places and under certain conditions.
22,038-49, 22,076-7. 1943, 2168-93.

627. It seems to us necessary before approaching the consideration of the utility of evacuation, to recognise, in the first place, that there are towns, such as Calcutta and Bombay, in which the removal from their houses of any material proportion of the population is impracticable. Even in towns of less size, total evacuation may not be a practicable measure. It might indeed be possible to remove all the residents of a large town, but it would be impossible to control them after removal. Again there are seasons in which evacuation must be productive of severe suffering and extreme inconvenience, and can at best be carried out only very ineffectually. The evidence given to us of the results of evacuation in the Satara and Dharwar districts during heavy rain, shows that evacuation as carried out in these conditions had, at all events in many of the evacuated villages, no sensible effect in checking the outbreaks of plague. It was found impossible in the stress of weather to prevent the people from returning to their houses. Where the rainfall is heavy and prolonged, the black cotton soil is converted into deep tenacious mud. It is vain to hope that the people will remain out of their houses at the times when these conditions prevail. Even where climatic conditions have not interfered to prevent evacuation from being carried out, it has often been impossible to take all, or even the majority, of the precautions which are necessary to obtain the best results from evacuation. With the large number of people and places that had at times to be simultaneously dealt with, the careful supervision necessary was frequently unobtainable.

Necessity for satisfactory test of results of evacuation.

628. What we have now to endeavour to see is whether evacuation of the degree of effectiveness which was as a rule obtained, has, on the whole, produced results sufficiently beneficial to counterbalance the discomforts that it inevitably entailed on the people. In this connexion we have chiefly to consider the effect of evacuation on the residents of the place evacuated, but, as we have seen, a subsidiary question comes up for consideration in connexion with the possible spread of plague to the residents of other places by the scattering of the evicted population.

We have a great deal of information regarding a large number of individual cases of evacuation. But before it can be established, from the statistical records placed before us, that in particular places the evicted people have been benefited by evacuation, we ought to have some satisfactory method of judging what would have happened to them had the place from which they removed not been evacuated. There is great difficulty in finding a test that is really applicable.

(i.) Test by comparing amount of plague before and after evacuation cannot be applied.

629. The most obvious method of investigating this question would be to compare the amount of plague before evacuation with the amount of plague after evacuation in individual places that have been evacuated. Judging by this method, it would appear that sometimes good results and sometimes bad results have followed from evacuation. In some instances the amount of plague has decreased, if not immediately, at all events within a short time, after evacuation. In other instances plague has continued for a long time after evacuation.

So many fallacies, however, enter into a comparison of this nature, that it is quite useless for the purpose of drawing any certain conclusion as to the results of evacuation.

In the first place, the actual process of evacuation in many cases occupied a long time. We, therefore, cannot in such cases take any particular dates and divide the period of observation into a period when the village was not evacuated, and into another period when the village was evacuated.

Again, it is impossible to ascertain how many of the persons attacked during the first few days after evacuation contracted the infection whilst still living in the infected place. Cases of plague thus originating ought to be reckoned as proof of the danger of remaining in the houses; they ought not to be adduced as disproof of the advantages to be derived from evacuation.

Moreover, even when the attacks after evacuation are more numerous than those before, it does not follow that they might not have been much more numerous still had there been no evacuation. In illustration of this, instances might be adduced in which evacuation, in all probability, did good, although attacks were more numerous after the vacation of the village site than before. We have for instance the facts reported from eight villages in the Dharwar 23,583-4. district. These villages, on the occurrence of mortality among rats, were evacuated by Captain Colomb before any case had occurred amongst human beings. Within 10 days of evacuation 1·1 per cent. of the population died of plague. The disease then stopped. Similarly, in the Palanpur State, six villages were completely evacuated because mortality among rats was observed. In one village there followed four cases, in 13,146-52. another two, in a third seven, in a fourth nine, in a fifth 10, and in a sixth 13. In the Dharwar and Palanpur instances alike, no one had died of plague before the evacuation, and people did die of plague after it. And yet, in all probability, the evacuation prevented a more serious outbreak than actually occurred.

Lastly, we may note that where the cases after evacuation are less numerous than they were before it, it cannot always be assumed that the decline is necessarily the consequence of evacuation. In some cases, we cannot exclude the possibility that the disease had already begun to decrease of its own accord, and was, indeed, on the point of expiring, at the time when the people came out. For instance, at Gharibabad, 3725-37, 3813-6, 11,162-70. 18,405-8. a hamlet of Sukkur town, with a normal population estimated at about 1,000, there was an outbreak in which about 400 were reported to have died in 16 days. On the 17th day the 601 people remaining in the hamlet were moved into camp. One developed plague within 24 hours of removal. None of the others were attacked. At Poona 4,800 persons were sent from infected parts of the city to the health camp at Bham- 21,832. burda. Only one case of plague occurred among them after removal. It is impossible to assert positively that evacuation produced this immediate cessation of cases. On the contrary, the fact that only one person in each of these instances was actually incubating plague at the time of removal may be used as an argument that the outbreak was already at an end in the quarter before the people were removed.

In view of the fallacies involved in a comparison of the statistics regarding the amount of plague before and after evacuation respectively, it is not possible by the adoption of this test to arrive at a certain conclusion as to the effectiveness or otherwise of evacuation.

(ii.) Test by comparing two separate outbreaks at same place, and under conditions similar except with regard to evacuation.

630. A second method of testing the effects of evacuation, would be to compare two separate outbreaks at the same place and under the same climatic conditions, in one of which the people were removed from their houses, and in the other of which they were not. Unfortunately, no instance has come to our notice in which a complete comparison of this kind could be instituted. The instance of Alibag is the one in which the conditions most nearly approached those which are essential for the institution of this comparison. 17,614. We think that the conditions at Alibag so closely approach the conditions which are essential, that the facts regarding the outbreaks in that town may be worth quoting. The first outbreak in Alibag was in the hot weather of 1897, the second in the hot weather of 1898. In the first there were 268 attacks in all; 54 in the four weeks ending 9th April, 167 in the four weeks ending 7th May, and 47 in the four weeks ending 4th June. In the second outbreak there were 26 attacks, viz., 17 in the last three weeks of March and nine in April. In the case of the first outbreak, there was very little evacuation, and it was resorted to only in the later stages of the outbreak; in the case of the second outbreak, there was a great deal of evacuation, though the town was not totally evacuated. The relative mildness of the second outbreak may, with probability, be ascribed to the adoption of evacuation, but it would not be fair to conclude that the good results in the second outbreak were entirely due to evacuation, and the bad results in the first outbreak entirely due to the failure to remove people from their houses. This test fails us for the want of any materials to which we can apply it.

(iii.) Test by comparing place evacuated with a place similarly situated and not evacuated.

631. A third method of comparison would be to contrast a place which was evacuated with another place similarly situated which was not evacuated. But there are hardly any towns or villages in which an outbreak has run its course without at least a large proportion of the people having removed from the infected place. A certain number of villages, however, in the Dharwar district were left unevacuated

owing to the impracticability of removing the people in the heavy rain. The mortality in these villages was extremely high, as the following details show :—

1601, 2226.

Name.	Population.	Percentage to Population	
		Of Attacks.	Of Deaths.
Shelwadi - - - - - -	4,222	32·5	27·6
Ibrampur - - - - - -	1,716	50·4	35
Byahatti - - - - - - -	3,589	30·5	21·7
Ingalhalli - - - - - -	2,203	47·7	36·8
Datnal - - - - - - -	1,280	45·3	36·5
Bhandiwad - - - - - -	1,306	Unknown.	37·1

23,164-7. Major Anderson, I.M.S., supplied us with figures as to the results of evacuation in 23 villages in the same district at a period of the year when the conditions of the weather were not so unfavourable. Excluding one village, for which the figures are incorrectly given, the aggregate population removed from these villages numbered about 34,100, and among them there were 2,073 cases of plague. The percentage of the population attacked was thus 6·07. Thus, in these villages even though, owing to the absence of a sufficient staff, it was impossible to exercise complete supervision over the evacuation, the amount of plague was far less than in the six villages mentioned above, which were not evacuated at all. It would, however, not be fair to assume that all villages unevacuated suffered as heavily as these six villages; in fact, we may assume that there must have been many villages where, even in the absence of evacuation, no outbreak serious enough to attract the attention of the authorities took place, although the infection must have been imported.

(iv.) Test by comparing the residents of an infected place who removed from it, with residents who did not leave the place, or returned to it prematurely.

632. A fourth test that suggests itself is to compare those residents of an infected place who removed from it and consistently remained out with those who either did not go out at all, or, having gone out, returned for some purpose or other. This test is, for obvious reasons, not one capable of general application. But observations in some places have been recorded of the relative liability to attack of these two sets of persons, and in such cases the test, so far as it can be applied, is a valuable one.

19,513. The people of Bobleshwar (in the Bijapur district) went out voluntarily into camp after there had been five cases of plague. After this no case occurred among them for a week. One family had been left in the village and they almost all caught plague. 24,545, 24,561. In Bholana, in the Khandesh district, the cases that occurred after the people had been living out of the village for a week were all traceable either to contact with patients in hospital or to residence in the village subsequent to the general evacuation. Two families, in which there were women who were about to be confined, were allowed to stay in the village. Their houses were at a distance from those previously infected. Within 10 days of evacuation a case of plague occurred in each family. 13,449-50. In four villages in the Cutch State, members of the clan to which the ruler of the State belongs were left behind in their houses when the rest of the villagers were turned out. It is said that as a class they do not associate with the other villagers, and it appears unlikely that they would have gone out of their villages in order to communicate with the people in camp. As a fact, no instance of their having done so was detected. In each of these four villages these people eventually became infected. In one of the villages the first person attacked was a woman who lived in strict seclusion, and the next two were her female attendants. 9217. Similar instances occurred at Khankhal in the North-Western Provinces. "The second area evacuated in Khankhal," says Mr. Winter, "contained the house of one of the leading men of the town. The house was well built and ventilated and kept scrupulously clean. For various reasons, we made an exception in favour of this man, and allowed him and his family to remain in their house. Two members of the family were attacked, although all the surrounding houses had been evacuated. A man was attacked with plague in a house from which a woman was about to be confined. The family of nine persons were segregated in their own house, the surrounding houses being evacuated; five members of the family were attacked. In another block that was evacuated there was a house from which a woman, owing to recent confinement, could not be moved. She, with two attendants, were left in the house. Her sister was attacked within a week of the evacuation. An old man and his sister were left in an evacuated area to look after a temple. The sister was attacked with plague two months after the surrounding houses had been evacuated, and after the whole town had been evacuated. After the outbreak had, to all appearances, ceased, four cases

occurred in a family living in a collection of huts separated from the town, which
for this reason had not been evacuated. Two chaukidars on duty in evacuated areas
were attacked." At Banga, in the Punjab, where batches of people were removed from 10,172, 10,236.
their houses on nine or ten different occasions, it was noticed that there was very little
plague in the camps, whereas the infection kept spreading among the people left in the
town.

It has also been observed that people who prematurely revisit a place that has been in- 12,645, 12,776,
fected are specially liable to attack. This has been specially noticed amongst disinfectors. 13,807, 13,814,
Mr. Winter speaking of Hardwar and the plague infected places in its neighbourhood, 15,776, 22,601.
observed: "Large numbers of men employed in disinfecting evacuated houses were 9217.
attacked, these attacks occurring for some time after the town or village had been
evacuated." In the case of Jawalapur, one of the places in question, out of a total of 9178
116 cases, 29 occurred among disinfectors or members of their families resident with 10,625, 10,139-41.
them. In 12 villages in the Punjab, of 102 cases which occurred after the tenth day 10,143-6, 10,515
subsequent to evacuation, 69 were among people proved to have visited the village -28, 10,603,
shortly before being attacked, and 21 of the cases were among disinfectors. Captain 10,685,
James' experience led him to say that disinfection was the most dangerous work. 10,000.
The facts which he gave us upon this point from the village of Mahlgahla are 9987, 10,139,
interesting. On the outbreak of plague there the whole village was evacuated, and 10,349.
the plague ceased. When subsequently the disinfection of the whole village was
undertaken, plague began again among the people engaged on this work.

Similar results were noticed in the Cutch State. "There is no doubt, says Major 13,456.
Hyde-Cates, "that the disease is kept going by people visiting the villages . . .
there is no doubt in my mind that people being allowed to visit their homes or doing
so surreptitiously keeps up the disease." A fact observed at Hinganghat bears upon 6007-9, 6021-5.
this question. On the 21st November 1898, 1,000 of the inhabitants of the town
were removed. There were no cases for some time in the evacuation camps. When,
however, on the 29th November permission was granted to return to the town
temporarily to get some grain, plague cases occurred on the 2nd December. The same
experience has been frequent in outbreaks of plague in the Kumaun and Garhwal Hills.
The feeling of the people there is so strong upon the subject that they are afraid 26,576.
to return to an infected village.

The results that ensue when the evacuated people in a body re-occupy their houses 13,431, 13,456,
prematurely are specially marked. Particularly notable are the results that occurred 13,678, 14,658,
at Chak Kalal in the Punjab, and in the Sirohi State. Dead rats were found in the 15,234, 15,739-41.
village of Chak Kalal on the 4th or 5th of April, 1898. The people thereupon left 10,603 (8).
the village. But on 15th April a heavy shower of rain caused most of them to return.
On 17th April the first case of plague occurred, and 33 persons were attacked between
that date and 27th April. In the four villages infected in the Sirohi State there were 9709, 9714,
18 deaths before plague was discovered. The villages were then evacuated. Subsequent 9792-3, 9825-6,
to evacuation nine cases occurred, all within 10 days. The outbreak then stopped. 9862-4, 9873-4.
On the people reoccupying their houses, however, plague broke out again in three of
the villages. These villages were again evacuated. In this second outbreak there
were 20 cases before the people went out and 36 afterwards. It seems clear that
the removal of the people from their houses saved them for the time from plague,
which they ultimately got by going back too soon.

The instances to which we have referred of persons who have become infected either while disinfecting houses in an infected place, or by a premature return from camp to the infected place, show conclusively that the risks of people contracting infection are greatly diminished by the fact of their removal from their infected houses.

(v.) Test by comparing course of plague in places promptly evacuated and places not promptly evacuated.

633. Finally, we have a fifth method of ascertaining to what extent the results of removing people from an infected place are beneficial. This is to compare the numbers of plague attacks and deaths in places from which the people were promptly removed with those in places from which they were removed after some delay. The method appears to be a trustworthy one, provided that the comparison is between a large number of villages evacuated early and a large number of villages evacuated late. But for its proper application it will not suffice to have statistics which merely set forth the number of cases and deaths before and after evacuation, such as some of those which have been furnished to us. It is necessary to have detailed accounts showing the circumstances in which each place was evacuated, and the facts attending the evacuation. The records given to us in evidence do not always show whether the evacuation of a place was real or nominal. In some instances, again, the case shown in the records as the first case of plague was apparently unconnected with the outbreak on account of which the place was evacuated, and was, at any rate, separated from it by a long interval of time. In other instances, where the process of evacuation took

considerable time, numbers of cases are shown as having occurred during the course of evacuation. An assignment of some of these cases to the period before, and of some to the period after, evacuation, would be arbitrary and misleading.

In the case of the infected villages in the Punjab, however, the statistics in the table furnished by Captain James, I.M.S., are supplemented, regarding each place evacuated, by the detailed account given on pages 16 to 92 of his Report on the outbreak of plague in the Punjab in 1897–98 (not reprinted with these Proceedings). This enables us to exclude from account certain villages which are not in all respects suitable for comparison, and to compare only those places in regard to which the information is complete. In respect of these villages there are full materials for coming to a conclusion as to whether plague was checked in promptly evacuated places more easily than in those in which evacuation was somewhat delayed. Captain James deals with 91 outbreaks of plague—75 in the Jullundur district, and 16 in the Hoshiarpur district—which occurred in 86 villages, of which five were infected twice. A consideration of the details given in Captain James' report and in his evidence shows, firstly, that in the case of 11 outbreaks, viz., the first outbreak in Jhander Khurd, the second outbreak in Aur, and the outbreaks in Khan Khanan, Malpur, Piragpur, Pharala, Sadhowal, Sanwali, Kulewal, Garhi, and Palewal, the date of the first case is not definitely known; secondly, that in the case of seven outbreaks, total evacuation was not effected, viz., in the cases of Naura and Garhshankar and of the first outbreaks in Aur and Karnana and the second outbreaks in Khatkar Khurd, Jhander Khurd, and Bahrwal; thirdly, that in the cases of Banga, Mukandpur, and Masani, the process of evacuation was protracted; fourthly, that in the case of Chak Kalal, the village was evacuated before any one of its residents was attacked, and that the people were attacked only when they were driven back to their houses by a storm; and, lastly, that in the case of one village, Parkhowal, no details are given regarding the dates on which cases occurring after evacuation happened. The evacuations connected with the outbreaks just enumerated in the 23 villages named, present features that prevent accurate comparison with the other cases of evacuation for which Captain James gives details. They must, therefore, be left out of account in the comparison which we are now about to institute. That comparison will relate to the cases of 68 outbreaks only
App. XXXIV. 9981. in the same number of villages, in regard to which we have full details, showing, with fair accuracy, the date of the first case of plague, the interval between the first case and the completion of evacuation, the number of cases before evacuation, the number of cases after evacuation—divided into (1) the number of cases in the first 10 days after evacuation, and (2) the number of cases which occurred more than 10 days after evacuation—and, finally, the date of the last case of plague. In order to ascertain what the effect of evacuation was, we have divided these villages into (1) those which were evacuated within 15 days of the occurrence of the first case of plague, (2) those which were evacuated more than 15 days, but less than a month, after the first case of plague, and (3) those which were evacuated more than one month after the first case of plague. This division of periods is purely arbitrary; but it will serve as well as any other.

The results of this comparison are shown in the following table:—

Villages.	Population.	Cases before Evacuation.	Percentage of 3 on 2.	Average Number of Days between the First Case of Plague and Evacuation.	Number of Cases within 10 Days after Evacuation.	Number of Cases more than 10 Days after Evacuation.	Percentage of Cases after Evacuation on Population.	Total Cases.	Percentage of Total Cases on Population.	Average Number of Days between Evacuation and Cessation of Plague.	Average Number of Days between First and Last Case.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
GROUP I.											
Thirty-five villages evacuated within 15 days of first case.	23,313	221	·95	6·3	465	159	2·7	845	3·6	22·3	28·6
GROUP II.											
Twenty-five villages evacuated over 15 days, but less than a month, after first case.	25,623	541	2·1	22	481	209	2·7	1,231	4·8	20·5	42·5
GROUP III.											
Eight villages evacuated more than a month after first case.	10,166	218	2·1	58	139	109	2·4	466	4·6	32·5	90·5

Over seven-eighths of the villages dealt with fall within the first two groups. The number of villages in each of these two groups, and, perhaps, in the third also, is sufficiently large to eliminate the element of chance, and the population of the villages is comparatively uniform within each of the different groups. The three groups of villages apparently differ from each other only in the facts that they were evacuated at different intervals after the outbreak of plague, and that there were considerable differences between the populations of the villages in the three groups, the average population being about 670, 1,025, and 1,270 respectively, in the first, second, and third groups. If a comparison is made between the severity and duration of outbreaks in villages evacuated within 15 days of the first case of plague and those evacuated after an interval of more than 15 days, but less than a month, it will be seen that the results obtained in the villages promptly evacuated were distinctly more satisfactory than those obtained in villages in which evacuation was delayed. The interval between the first and last case of plague was in the first group less by about one-third than that in the second group. The incidence of attack taken over the whole period during which plague lasted was in the former 3·6 per cent. and in the latter 4·8 per cent. on the population. Thus, in the two essential points, viz., in the reduction of the number of cases and of the period for which the outbreak lasted, a material advantage resulted from prompt evacuation. The third group of villages, viz., those not evacuated till more than one month after the first case, numbers only eight. The results in these villages do not show quite as large a total mortality as those in Group II., but a larger mortality than in Group I. The period of outbreak was more than twice as long in this group as in Group II., and more than three times as long as in Group I.

The facts here exhibited, if they were not complicated by the circumstance that they relate to groups of villages of different average populations, would appear to afford very distinct proof of the beneficial results of prompt evacuation in villages when special means are adopted for disinfection of the effects taken out into camp, the isolation of the sick, and the proper control of the people in camp.

Opinions of the officials and people regarding benefits of evacuation.

634. The above statistical tests, so far as they can be applied, show that evacuation is certainly a beneficial measure where the special precautions to which we referred above have been taken, and that, considered generally, it is probably a beneficial measure.

9, 1699, 3396, 4292, 6024–6, 7854, 9225, 10,464, 10,757, 11,482, 11,960, 12,654, 12,755, 16,969, 17,666, 18,421–2, 18,585, 19,482, 19,952, 20,233, 20,441, 23,928–9, 24,549, 26,543–4.

The statistical evidence, however, is not the only evidence laid before us with respect to the results of evacuation. There is a large body of opinion and it is practically unanimous in declaring evacuation to be a good measure. This opinion is not merely that of Government officials, whether European or Native, but also that of the officials of Native States and of persons who are not officials. Many of those most experienced in plague administration consider evacuation the most effective of all measures. They have assured us that the removal of the people from an infected place is followed by a diminution and gradual decline in the number of cases. They assert that, at any rate in well-controlled camps, cases are more easily discovered, and that the infection spreads less than in the village site, and that people who develop the disease after they have been out more than a few days have generally contracted it not in the huts but by visits authorised or surreptitious to the houses. A body of opinion like this which is based upon the experience of practical men throughout the length and breadth of the infected districts is, we think, entitled to great weight. With a view to showing the opinions which are held by officers who
have actually been engaged on plague duty, we may quote the following. "It is fairly 10,361.
well established," says Captain James, I.M.S., speaking of the Punjab, "that in evacuation of villages we have a method of quickly and certainly stamping out plague. In not a single village in the areas under consideration could it be said to have failed. It was successful in every season of the year, though it took longer in the winter than in the summer. It was equally successful in large villages of from three to four
thousand people as in little hamlets." Experience gained in the outbreaks at Hardwar 8791.
and its neighbourhood convinced Colonel Thomson, I.M.S., the Sanitary Commissioner
of the North-West Provinces, that evacuation is the best remedy. The Commissioner 11,248.
in Sind says: "Evacuation is the one thing: every officer recognises that
evacuation is successful." Sirdar Muhammad Yakub Khan, who had experience 25,186.
of the plague in Sind, is strongly of opinion that evacuation stops an extending
epidemic. And Mr. Kaka, the Health Officer of Karachi, considers that the one 11,849–50.
measure that has proved successful in combating plague is the compulsory evacuation
of infected areas The Civil Surgeon of Surat thinks that of the several measures 15,764.
adopted the most valuable in the treatment of an epidemic is evacuation. Mr. Monteath.
the Assistant Collector of the Thana district, says "the most effective measure seems 19,684.

to be to turn all the people out, or as many of them as possible, into the fields."
24,449, 24,456. Evacuation and thorough ventilation of all the infected houses for a month
kills plague, says Mr. Moore, who had experience both in Surat and Nasik.
21,667. Evacuation and isolation are, Assistant-Surgeon Bharucha considers, very important;
evacuation produces better effects, he says, when isolation is added. In spite of
the fact that in the Satara district attempts at evacuation were often—chiefly
22,031. it seems because of heavy rain—productive of so little good, the Collector considers
that the most effective practical measure for stopping plague is "trying to evacuate
and evacuating as much as possible." The general impression produced on his mind
22,046. in regard to complete evacuation properly carried out is that "plague undoubtedly
does begin to decrease soon after the people have gone out; within, I should say, a
22,737. fortnight." His assistant, Lieutenant Steen, while thinking that unless evacuation
comes very promptly before many people have become infected it will not stop plague,
thinks apparently that it will at any rate diminish it. Lieutenant Anderson, who
22,595. worked in the same district, thinks that the great remedy when a village is infected is
23,168. "entire evacuation immediately." Major Anderson, I.M.S., considered that evacuation
had been very successful in the part of the Dharwar district of which he had charge.
23,507. And Mr. Bhardi, who had served in the same district, thinks that the best measure
20,238. for suppressing the epidemic is evacuation. The Collector of Sholapur told us
that, in his opinion, "the immediate and complete evacuation of all villages, and of
towns up to 40,000 or 50,000 inhabitants, when this is considered possible, is the
22,891. best way of treating an outbreak of plague." Similarly, the Collector of Belgaum,
when asked what he considered the best measures to adopt, the most effective steps
to take, when plague had occurred in a district or village, replied, "for the people to
21,320-1. go out and evacuate a village." Major Ross writes—and Lieut.-Colonel Fawcett,
R.A.M.C., entirely endorses the view—that at Poona "the effect of health camping
13,452. was almost magical." "Most of the villages," says Major Hyde-Cates, referring
to places attacked by plague in the Cutch State, "that have been turned out early
gave good results, and I have not the least hesitation in saying that early
evacuation properly carried out is the best thing." In the Mysore State,
3306. Mr. Madhava Rao, the Plague Commissioner, found that when the villagers camped
out there was "abatement of plague. There have been no more cases so far as the
15,221. camping out is concerned." "The best of all measures," says Mr. Dhurandhar, an
14,662. officer of the Baroda State, "is evacuation." "In cases where we could evacuate the
villages," says Mr. Samarth, employed in the same State, "the evacuation was very
satisfactory; the disease stopped very soon after they went into the fields." And
15,115, 15,124. Mr. K. B. Jadhav, the District Magistrate of Naosari, in the Baroda State, says that
evacuation often stops plague within a week, and "is the only measure, which the
5926. people are ready to adopt of themselves." Mr. Mazhar Hussain, who served in the
Hyderabad State, says, that "after the evacuation of a village the fall in the mortality
22,532. was very striking." "Evacuation," says Mr. Ghanekar, a member of the Municipal
24,312-3. Committee of Satara, "is the most successful remedy." Mr. Cardmaster, of
Ahmednagar, is "quite positive" that evacuation is the most effective measure.

9, 11,375, 14,635, 22,635. It is not only the officials of the British Government and of the Native States who
believe in the efficacy of evacuation; the villagers themselves, as we have seen above,
are becoming convinced of the necessity of vacating their houses on the appearance of
plague.

Effect of evacuation in causing spread of plague to places other than that evacuated.

635. We have now to consider the subsidiary question as to whether evacuation
indirectly causes a spread of plague to places other than the one evacuated. Whether
evacuation will have an effect in spreading the plague to uninfected places
depends, firstly, upon the extent to which plague has spread among the inhabitants of
the evacuated place, and secondly to the extent to which these inhabitants after evacuation disperse themselves over the country. The interests of agriculturists are in their
5891, 13,084, 20,237, 21,148, 23,680, 23,968-91, 24,067-74, 24,359. fields, and when removed from their houses they have no inclination to go away to a
distance, so that the turning of such people out of their houses probably does not
result in the dissemination of plague, even though there may be many of them
infected. But where infection is widely distributed in a large place containing traders
and artisans there is the danger that evacuation may result in the dissemination of
plague, because, as trade comes to a standstill, these classes run away to other places
and carry the infection with them. It was by people flying from Sholapur—before
and after the evacuation—that the country round, both in British territory and
5425, 23,332-8, 23,912, 24,016. Hyderabad territory, was flooded with plague. The infection in Sholapur died out,
but the villages in the Hyderabad State, infected by refugees from the town, have
remained continuously infected ever since.

The view might be taken that even though the evacuation of a place results in the infection of other places, still, less harm will be done by evacuating an infected place than by leaving it unevacuated. In support of this contention it may be urged that where there is a large place infected, other places are certain to get infected from it, whether it be evacuated or not; that the secondary foci of infection which would be started in great numbers by the evacuation of such a place could all be rapidly extinguished by a series of successive evacuations; and that the result will thus be that the plague will be extinguished sooner than if it had been allowed to smoulder on for an indefinite period in the original focus of infection, and to spread out slowly from that focus, with the ultimate result that the loss of life would, without evacuation, be greater. The point is no doubt a difficult one, the question being one of the balance of advantage. So far as experience has gone at present it points, in our opinion, to the advisability of agitating the people of a large place as little as possible, when infection is widely distributed among the inhabitants, so as not to drive them out of the town. 26,546-7.

Evacuation would be unnecessary if plague could be checked by disinfection or inoculation.

636. Our conclusions are to some extent stated in our previous remarks. Before summing them up, we may note here that a policy of evacuation only comes into consideration in cases where no effective alternative policy can be adopted.

If it were possible to disinfect in a prompt and efficient manner every infected house, it would not be necessary to resort to evacuation. It would be sufficient to remove the people from their houses and to keep them out only for such time as might be necessary for the completion of the process of chemical disinfection. We shall, however, see that efficient disinfection requires the employment of properly trained and costly establishments, and these are not everywhere available. It will be impossible to attain by chemical disinfection the objects aimed at by evacuation, except in a comparatively few instances.

Again, if it were possible to immunise the people so as to prevent them from contracting the infection while they remained in their plague infected houses, evacuation would become unnecessary. Although we are satisfied of the benefits of inoculation, according to Mr. Haffkine's method, we have seen that inoculation as at present practised does not protect absolutely from an attack of plague, and moreover there is great practical difficulty in getting the whole of the residents of a place inoculated so quickly as to keep the plague in check by this means. We cannot anticipate that it will, in the near future, at all events, be possible to attain completely by means of inoculation the object aimed at by evacuation.

Conclusions regarding evacuation.

637. The importance of evacuation as a policy having thus become manifest, we may sum up our opinion regarding it as follows. We consider that evacuation is generally beneficial, that it is highly beneficial when the safeguards necessary to its giving its best results can be maintained, and that it is beneficial even when they cannot be completely maintained. There are, however, two sets of conditions in which evacuation cannot be carried out without doing harm which may more than compensate for its good results. Evacuation, in the first place, does more harm than good when amongst the people who are removed from their houses there is a considerable number who belong to the trading or artisan classes, for, inasmuch as traders and artisans may lose their occupation by being removed from the town, they are likely to run away and infect other places. Evacuation, in the second place, almost always does more harm than good during the rainy season, especially in certain tracts of country where the effects of the rains are most severely felt, and it is impossible to keep the people, after they have once been removed from their houses, from going back to them; and in such circumstances the evacuated people are exposed to great inconvenience and misery without deriving any countervailing advantages from evacuation.

III.(4)—*Disinfection.*

Disinfection.

638. Under the heading of disinfection we may consider all the various agencies which operate in the direction of destroying the germs of plague when these have been disseminated in nature.

III.(4.)(*a.*)—*Question as to what is the most Effective Chemical Disinfectant for Plague.*

Disinfection by chemical means.

639. We may conveniently begin by the consideration of the action of chemical disinfectants.

The question as to what is the most effective disinfectant to employ in the case of a particular disease can be answered only by determining by experiment what quantities of each particular disinfectant are required for the destruction of the micro-organisms of that disease. This information can be obtained from two distinct sorts of experiments:—

(*a.*) It may be deduced, on the one hand, from experiments in which additions of disinfectants are made to pathogenic micro-organisms suspended in a medium which is both inert with respect to the bacteria, and which does not exert an important neutralizing action on the disinfectant. The information derived from experiments of this kind will only in exceptional cases have a direct application to practice, inasmuch as the media which surround the pathogenic micro-organisms in nature are media which will decompose and combine with the disinfectant in such a manner as to diminish its action on the pathogenic bacteria.

(*b.*) On the other hand, the information as to which is the best disinfectant to apply may be derived from experiments in which the disinfectants are applied under the conditions which actually obtain in nature, or under conditions which closely approximate to these. The information derived from experiments of this kind will manifestly be information which is more likely to be directly applicable to practice.

The minimum strength of particular disinfectants required to devitalise the plague bacillus in an inert medium.

640. We may begin with the consideration of the more important experiments which have been instituted with a view of determining what is the minimum strength of each particular disinfectant which is required for the complete devitalisation of the plague bacillus when suspended in a practically inert medium. We may deal only with the more important disinfectants.

(1.) *Carbolic Acid.*

(1.) Carbolic acid.
British Medical Journal, 7th July 1894.

Kitasato found that a minimum addition of 1 per cent. of carbolic acid was required for the destruction of the plague bacillus in bouillon cultures within one hour. Carbolic acid in a strength of 0·75 and 0·50 per cent. did not destroy the bacillus within one hour in bouillon cultures, but did so after two hours.

Centralblatt für Bacteriologie, 1897, p. 497.

Abel found that the plague bacillus on agar cultures was not destroyed by exposure to 1 per cent. of carbolic acid for a period of six hours, but was sometimes killed after 24 hours; it was always killed in his experiments in 48 hours. On cover glasses smeared with infected pus or with agar cultures, the bacillus was alive after one hour's exposure to 1 per cent. of carbolic acid, but not after two hours.

8552 (II., 5).

Mr. Hankin found that the plague bacillus was not invariably destroyed by an exposure of 20 minutes when introduced into 1 per cent. carbolic acid.

Report of German Plague Commission, p. 278.

The German Plague Commission found that plague bacilli were destroyed in one minute when introduced into 5 per cent. carbolic acid. They were killed in 1 per cent. carbolic acid in a period of 10 minutes. They survived exposure for an hour to $\frac{1}{2}$ per cent. carbolic acid.

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In a series of experiments conducted by us, the addition of carbolic acid to a bouillon culture of plague till the mixture contained $\frac{1}{2}$ per cent. of carbolic acid did not kill the bacillus in 24 hours. An addition of 1 per cent. of carbolic acid effected the destruction of the bacillus in less than 10 minutes, and an addition of 5 per cent. killed the bacillus immediately.

(2.) *Phenyle.*

(2.) Phenyle.

Phenyle, which is the commercial name for a "distillate containing various phenols and cresols," is, as will be seen further on, a disinfectant which has been very extensively employed in India.

8552 (II., 5).

Mr. Hankin found that the plague bacilli were killed in 5 to 10 minutes by an emulsion of phenyle of strength of 1 in 1,000.

Capt. James' Report, p. 111.

Dr. Watkins Pitchford (Report from the Petit Laboratory, April 23rd, 1898, quoted by Capt. James, I.M.S., in his Report on the plague in the Punjab in 1887–8), found that plague bacilli were killed within five minutes in a solution of 1 in 400 of phenyle.

(3.) *Soft Soap Solution.*

(3.) Soft Soap.
Report of German Plague Commission, p. 278.

The German Plague Commission found that plague bacilli remained virulent for mice, after exposure for 15 minutes to a 3 per cent. solution of soft soap, kept at a temperature of 30° C. The bacilli lost their virulence after exposure to the same solution for half-an-hour at a temperature of 30° C.

(4.) *Lysol.*

(4.) Lysol.
8552 (II., 5).

Mr. Hankin found that plague bacilli were killed by an exposure of five minutes to a $\frac{1}{4}$ per cent. solution of lysol. No experiments are reported with weaker solutions.

The German Plague Commission found that plague bacilli were killed in five minutes by a 1 per cent. solution of lysol, and in one minute by a $2\frac{1}{2}$ per cent. solution. No experiments are reported with weaker solutions.

Loc. cit. p. 278.

(5.) *Perchloride of Mercury (in Neutral Solution).*

Mr. Hankin found that perchloride of mercury in 1 in 5,000 solution killed off plague bacilli. We understand that the plague bacilli were, in this experiment, exposed to the action of the disinfectant only for one minute.

(5.) Perchloride of mercury (in neutral solution). 8552 (II., 6).

Abel found that 1 in 5,000 solution of perchloride of mercury killed plague bacilli in one hour, while 1 in 1,000 of perchloride of mercury killed plague bacilli within 10 minutes.

18,828. Loc. cit.

The German Plague Commission found that plague bacilli when brought in contact with a 1 in 1,000 solution of perchloride of mercury instantaneously lost their virulence for mice.

Report of German Plague Commission, p. 279.

Dr. Watkins Pitchford found that perchloride of mercury in a solution of 1 in 5,000 killed the plague bacillus within five minutes.

Capt. James' Report, p. 111.

In our own experiments it was found that the plague bacillus was, in all cases, killed in 15 minutes by 1 in 5,000 solution of perchloride of mercury; in one case it was killed in 15 minutes in a 1 in 10,000 solution; in another case it was killed by half-an-hour's exposure to a 1 in 20,000 solution of perchloride of mercury.

26,347 and 26,434A.

(6.) *Mineral Acids.*

Mr. Hankin found that the plague bacillus was killed by exposure (for a period of time which is not stated) to nitric acid in a strength of 1 in 333, to hydrochloric acid in a strength of 1 in 500, and to sulphuric acid in a strength of 1 in 1,500 nearly.

(6.) Mineral acids. 8552 (II., 7–8).

The German Plague Commission found that the plague bacillus was killed in five minutes by sulphuric acid in a strength of 1 in 2,000, and within half-an-hour by hydrochloric acid in a strength of 1 in 1,000.

Loc. cit., p. 279.

Our own experiments gave similar results.

(7.) *Caustic Lime.*

Mr. Hankin found that plague bacilli were not killed by exposure to the influence of a solution which contained caustic lime in excess. Mr. Hankin has omitted to specify the duration of the exposure in question.

(7.) Caustic Lime. 8552 (II., 6).

The German Plague Commission found that a minimum exposure of 30 minutes was required to effect the destruction of plague bacilli. The solution which was employed also contained an excess of caustic lime.

Loc. cit., p. 280.

(8.) *Permanganate of Potash.*

Mr. Hankin found that plague bacilli were killed by exposure for a period of five minutes, to 1 in 10,000 solution of permanganate of potash.

(8.) Permanganate of potash. 8552 (II., 9, 10).

(9.) *Chloride of Lime.*

Mr. Hankin found that plague bacilli were killed by an exposure of five minutes to a 1 in 10,000 solution of chloride of lime.

(9.) Chloride of Lime. 8552 (II., 9).

The German Plague Commission found that a minimum exposure of 15 minutes was required to effect the destruction of the plague bacillus by a 1 per cent. solution of chloride of lime.

Loc. cit.

641. Before we proceed to formulate the conclusions which can be drawn from the results of the experiments which have been summarised above, it would be well for us to place clearly before us the fallacies which may vitiate such experiments as these.

Fallacies which may vitiate experiments of which results given above.

The fallacies in question are the following :—

- (*a.*) The experiments may be undertaken with cultures which have already become attenuated. There would result from this an over-estimation of the efficacy of the disinfectant.
- (*b.*) The fluid which is employed for suspending the bacteria may itself exert a bactericidal effect. There would result from this an over-estimate of the efficacy of the disinfectant.
- (*c.*) The fluid in which the bacteria are suspended, and which is introduced with them into the solution of the disinfectant, may neutralize some of the disinfectant, with the result that the strength of the disinfecting solution may be reduced below the standard to which it is supposed to correspond. There would result from this an under-estimation of the efficacy of the disinfectant.

(*d.*) When, for the purpose of testing the survival or non-survival of the bacteria which have been introduced into the disinfecting solution, these are transferred to a nutrient medium, some of the disinfectant may be carried across into the nutrient medium, with the result that the growth of the bacteria on this medium will, to a greater or less extent, be inhibited. Where this is the case, the inference that the bacteria have been devitalised might be erroneously made. There will thus be a risk of the devitalising efficacy of the disinfecting solution being over-estimated.

In the case of the experimental results which have been summarised above, information is not always available as to the details of the experiments upon which these are based. Where these particulars have been omitted we can have no certainty that all fallacies were avoided, and it is possible that certain discrepancies in the experimental results summarised above may be referable to such fallacies. Again, in other cases, for instance where the disinfectant employed is a very unstable or volatile disinfectant, such as chloride of lime, the discrepancies between the results of various observers may be due to differences in the strength of the disinfectant employed. On the whole, however, we may notice that there is, on fundamental points at any rate, a very satisfactory amount of agreement between the results obtained by the different observers.

Inferences that can be drawn from above experimental results.

642. We learn from the above summary of the experimental results first, that carbolic acid when employed in dilute solutions (1 per cent. or under) is not a very powerful disinfectant.

We learn, further, that caustic lime is not an effective disinfectant.

We learn, lastly, that perchloride of mercury, mineral acids, permanganate of potash, and solutions and preparations which contain free chlorine (fresh chloride of lime, and, possibly, freshly prepared chlorinated sea water, come under this description), are extremely effective disinfectants.

We learn, in other words that mineral acids on the one hand, and oxidising agents on the other hand, are, as Mr. Hankin has already pointed out, effective disinfecting agents, whereas caustic alkalies are relatively ineffective.

Question of practical application of above inferences.

643. With regard to the practical application of these experimental results, attention has already been drawn to the fact that inasmuch as the conditions of experiments such as these are altogether different from those under which disinfectants are applied in actual disinfections, the results of such experiments will only in exceptional cases have a direct application to practice. We have in view here such experiments as those which refer to caustic lime. It would appear to be legitimate to infer from the inefficacy of this disinfectant in test-tube experiments such as those considered above that the whitewashing of houses cannot, even under the most favourable circumstances, be a very effectual disinfecting measure. On the other hand, we cannot infer from the similar experiments with permanganate of potash that this disinfectant, which is so effective when brought into relation with plague bacilli suspended in an inert medium, will also prove an effective disinfecting agent when applied in actual practice. This question will be determined primarily by the degree to which permanganate of potash will be decomposed and neutralised by the particular media in which the plague bacillus is found in nature.

Considerations bearing on the value of permanganate of potash as a disinfectant for use on cow-dung floors.

644. The issue, so far as it relates to the particular case of permanganate of potash, in its application to the disinfection of earth and cow-dung floors which have everywhere to be dealt with in India, is brought clearly before us by the following facts. On the one hand, we have the fact that permanganate of potash, even in a solution of 1 in 10,000, exerts a devitalising action on the plague bacillus. On the other hand, we have the fact that permanganate of potash is notoriously subject to decomposition when
8552. it is brought in contact with any kind of organic material. Let us note as an indication of the degree to which permanganate of potash is decomposed when it comes in contact with cow-dung, the fact that cow-dung is, as Mr. Hankin has shown, capable
II., 10. of exerting a deoxidising effect upon its own weight of a 4 per cent. solution of permanganate of potash. It, will however, appear on consideration that the degree to which the disinfecting power of permanganate of potash will be diminished when it is applied to an earth and cow-dung floor cannot be directly deduced from the above observations, which tell us that cow-dung is capable of decomposing $\frac{1}{25}$th of its weight of the disinfectant. We cannot, in other words, draw from the experiments in question the conclusion

that permanganate of potash will fail to kill off the plague bacillus in cow-dung when it is employed in a solution weaker than 4 per cent. For to assume this would be to assume that the permanganate would completely expend its force upon the oxidation of the cow-dung before it began to attack the plague bacilli incorporated in that cow-dung. Now we have no warrant for asserting that this is what actually occurs. On the contrary, it is quite conceivable that the permanganate might exert its oxidising power first upon any plague bacilli which might be present, and only afterwards upon the cow-dung with which these were incorporated. The question as to whether the disinfectant would attack the bacilli before it attacked the cow-dung, or the cow-dung before it attacked the bacilli, is a question which is determinable only by direct experiment. We may, however, see an indication of the answer which would be arrived at in the fact that Mr. Hankin found that a solution of 1 in 200 of permanganate of potash was capable of killing off plague bacilli when added to an agar culture of these. It is manifest, therefore, that plague bacilli may be killed off by solutions of permanganate of potash even in the presence of an excess of oxidisable organic material. 8552 (II. 9).

Considerations bearing on the value of perchloride of mercury as a disinfectant for use on cow-dung floors.

645. The case is not essentially different with regard to perchloride of mercury. As stated above, the plague bacillus when suspended in an inert medium was, in one of our experiments, killed off in 15, and in another of our experiments in 30, minutes, in solutions of 1 in 10,000 and 1 in 20,000 of perchloride of mercury respectively. These dilutions are not, as will be seen, substantially different from the minimum dilutions in which permanganate of potash is effective. Now, just as in the case of permanganate considered above, so here, we must keep in view that these figures refer to conditions where the disinfecting solution comes into operation on bacteria suspended in an inert medium. We must not therefrom infer that it will suffice, in a case where we desire to effect the devitalisation of any plague bacilli which may be contained in an earth and cow-dung floor, to impregnate the floor with a solution of perchloride of mercury of a strength of from 1 in 10,000 to 1 in 20,000. For it is manifest on general chemical principles and, indeed, it has also been shown by direct experiment, that an earth and cow-dung floor contains considerable quantities of ammonia, and large quantities of other substances, which will decompose and neutralise the perchloride of mercury. Further, it is manifest from general considerations that a considerable quantity of albuminous material will be contained in every earth and cow-dung floor. This albuminous material also will enter into chemical combination with the perchloride of mercury. How much perchloride of mercury would be decomposed in these ways by an ordinary earth and cow-dung floor does not appear ever to have been directly determined by chemical methods. But we have to note that, as in the parallel case of permanganate of potash, the efficacy of perchloride of mercury as a disinfectant could not be directly inferred from a chemical determination of the amount of perchloride of mercury which an earth and cow-dung floor is capable of decomposing. The problem which it really concerns us to solve is the problem as to how much of the disinfectant would be decomposed by the floor before a devitalising action is exerted on the plague bacilli incorporated in that floor. The question is plainly one which can only be determined by direct bacteriological experiments. 26,434 A. 26,347.

We may, therefore, now pass on to consider the experiments which have been instituted with a view to resolving this problem.

III.(4.)(*b.*)—*Experiments to test the Practical Value of Perchloride of Mercury as a Disinfectant for Cow-dung or Earthen Floors Infected with Plague.*

Difficulty of experiments to determine the strength of disinfectant required to devitalise the plague bacillus when incorporated in a cow-dung or earthen floor.

646. It would, on first approaching this question, appear to be a simple matter to determine by bacteriological methods the exact amount of disinfectant which would have to be applied to bring about the destruction of plague bacteria in a plague-infected floor. The difficulties of determining this by direct methods are however very considerable. How great these difficulties are will be clearly seen from the fact which we have pointed out that, in spite of the many efforts which have been directed to this end, no observer appears ever to have been successful in recovering plague bacilli from an infected floor. Such being the case, it is manifest that it is impossible to base any inference upon the fact that the plague bacteria are not recovered from the floor which has undergone a process of disinfection with a particular disinfectant, or with a particular strength of disinfectant. Pending the discovery of a method which shall allow of the isolation of the plague bacilli incorporated into unsterilised cow-dung or similar material, it will not be possible to obtain evidence of the efficacy or otherwise of a disinfectant by searching for the plague bacillus in the infected house after the completion of a disinfection process. Para. 222 of this Report.

Methods of conducting such experiments.

647. We are thus, when we desire to determine the effectiveness or otherwise of a disinfecting process, constrained to have recourse to less direct methods of experimentation. If we insist upon judging of the efficacy or otherwise of a disinfection process by ascertaining the destruction or survival of the plague bacillus in the floor materials, we may adopt (*a*) Dr. Marsh's method of artificially introducing the plague bacillus into the sterilized or unsterilized floor material in such a manner as to make sure that it shall be possible subsequently to recover it, should it survive the disinfection process. Failing the adoption of this method, we may leave altogether out of view the plague bacillus and find our criterion of the efficacy of a disinfecting process either in (*b*) a large reduction of the total number of the bacteria in the floor, or again we may find it in (*c*) a destruction of all but the more resistant forms. Of the two methods of testing the efficacy of a disinfecting process which have been last mentioned, the former has been adopted by Mr. Hankin, and also in some instances by Dr. Marsh, while the latter has been employed in a series of experiments made by ourselves.

(*a*) Experiments to test the destruction or survival of plague bacilli introduced into floor materials treated with perchloride of mercury. Dr. Marsh's experiments. 18,829–46. Para. 641 of this Report.

648. We may begin by the consideration of the very careful series of experiments which were instituted by Dr. Marsh, with a view of determining in what strength a perchloride of mercury solution ought to be applied to the disinfection of a cow-dung floor. The details of the method of experimentation which Dr. Marsh adopted are as follows:—The cow-dung, or mixture of cow-dung and earth, was first very finely pulverised. Weighed quantities of these materials were then filled into a series of test tubes, the quantities in the various test tubes being so arranged as to constitute a graduated series. A plague-infected glass bristle was in the case of each tube thrust down into the depth of the pulverised material in such a manner as to stand upright. With a view to avoiding the third source of fallacy, which was referred to above when we were considering the fallacies which are incident to experiments on the efficacy of disinfectants, this bristle was first washed so as to remove any excess of the culture medium that might be adhering to it. Ten cubic centimetres of a perchloride of mercury solution were then introduced into each tube. After 18 hours the glass bristles were withdrawn from the pulverised floor material into which they had been thrust. With a view to removing any adhering perchloride of mercury, the bristles were then agitated in a weak solution of carbonate of soda. This done, the bristles were separately inoculated into nutrient broth, or into liquefied nutrient agar which was afterwards poured out into a Petri's dish, so as to obtain isolated colonies.

The results of the two most important series of experiments which were instituted by Dr. Marsh were as follows:—10 c.c. of a solution containing 1 in 725 of perchloride of mercury, 1 in 1,015 of chloride of ammonium, and 1 in 152 of hydrochloric acid, is the minimum volume of this solution which suffices to devitalise plague bacilli, incorporated by the method described above into (*a*) 2 grammes of previously unsterilised cow-dung, or (*b*) into 0·7 gramme of a mixture of cow-dung and earth from an ordinary floor.

Criticism of Dr. Marsh's results with regard to the form in which they are expressed.

649. Two points in particular seem to invite criticism in these experiments.

The first of these points relates rather to the form in which the results of the experiments are expressed than to the essentials of the experiments. We shall find it convenient to dispose of this first. We may introduce what we have to say in this connexion by pointing out that in the case of test-tube experiments, when solutions of a disinfectant are employed which exceed a certain minimum concentration, it will probably be a matter of indifference, so far as the results are concerned, whether the disinfectant is brought into relation with the material which is to be disinfected in the form of a more or of a less concentrated solution. It would, for instance, in the case of such test-tube experiments as we are here considering, probably be a matter of indifference whether the quantum of perchloride of mercury which was employed to effect the devitalisation of the plague bacillus is introduced into the test-tube in the form of 10 volumes of a 1 in 10,000 solution, or in the form of one volume of a 1 in 1,000 solution, provided always that the quantity of disinfecting solution employed suffices for the saturation of the cow-dung. For, inasmuch as the fluid cannot here run off, every portion of the disinfectant would manifestly sooner or later come into contact with the material which is to be disinfected. The conditions in test tubes are in this respect quite other than those which exist when the disinfectant comes to be applied in the practical disinfection of a room. It will not suffice for practical guidance in the disinfection of a room to have arrived at the conclusion that 2 grammes of cow-dung can be disinfected by 10 c.c. of a particular disinfecting solution, for, even if there were a ready method of estimating the weight of a floor which is to be disinfected, and the amount of disinfecting solution required for it, it would hardly be possible effectively to apply the enormous volume of disinfecting solution that would be required. The principle which must in practice govern the application of a disinfectant to an infected floor is to use a disinfecting solution of such strength that the volume of fluid which will be absorbed by the floor shall contain a sufficiency of the disinfecting element to produce the effect desired.

Re-statement of the results of Dr. Marsh's experiments.

If now, taking the results of Dr. Marsh's experiments as given by him, we proceed to calculate out the minimum strength of disinfecting solution which would be required for disinfecting a cow-dung floor, we must obviously take as a basis for our calculations the amount of fluid which can be absorbed by such a floor. On the question as to the amount of fluid which would be absorbed by an ordinary cow-dung floor, we have very few data available. Such data as we have been able to find consist (*a*) in a statement of Mr. Hankin, from which we gather that 1 gramme of cow-dung will absorb at most 1 c.c. of fluid, and (*b*) in a statement of Dr. Marsh, that 2 c.c. of water suffice to moisten thoroughly 1 gramme of cow-dung. If in default of completer information we take the mean between these two estimates as the basis of our calculations, we may assume that every gramme of cow-dung floor will absorb 1·5 c.c. of fluid. Now, neglecting for the reasons given above, the quantity of fluid in which the disinfectant was applied in the test-tube experiments, we find that Dr. Marsh ascertained ·014 grms. of perchloride of mercury to be necessary to devitalise the plague bacilli incorporated in 2 grms. of unsterilised cow-dung. Thus, we have two facts to consider together, viz., that every gramme of a cow-dung floor will absorb 1·5 c.c. of fluid, and that it will require ·007 grms. of perchloride of mercury for its effective disinfection. It is from these facts clear that to obtain an effective disinfecting solution, every 1·5 c.c. of the solution in which the disinfectant is applied must contain ·007 grms. of perchloride of mercury. The solution must, therefore, be one of a strength not below 1 in 215 if employed for the devitalisation of plague bacilli incorporated in cow-dung. If employed for the disinfection of an ordinary earth and cow-dung floor, the solution employed must, on a similar calculation, be of a strength of 1 in 75. These results are sufficiently startling in view of the fact that a strength of 1 in 1,000 or thereabouts has been the strength of this particular antiseptic, which has ordinarily been thought to be sufficient for the sterilisation of a cow-dung floor.

8552 (II., 10).
18,842.

Criticism of Dr. Marsh's experimental procedure.

650. The significance of Dr. Marsh's results having been made clear, we now proceed to the consideration of his experimental procedure. We have seen above that the method which was employed by Dr. Marsh was to thrust the plague-infected extremity of a glass bristle down to the depths of the powdered material, and then to pour the disinfecting solution on the surface. In accordance with these dispositions it is obvious that the disinfectant had to penetrate the whole of the material before it reached the plague bacilli at the extreme end of the glass bristle. In other words, the arrangements in the experiments were such that the disinfectant could not take effect upon the bacilli at the end of the glass bristle until it had passed through and had inter-acted, so far as it was capable of doing so, with every portion of the enveloping material. We can no more make an inference from this as to what quantity of perchloride of mercury would, under ordinary circumstances, be required for the devitalisation of the plague bacillus in a medium of cow-dung, than we can, from the data given us by Mr. Hankin with respect to the reducing power which cow-dung is capable of exerting on permanganate of potash, make an estimate of what amount of permanganate of potash will be required under similar circumstances. Again, the disposition of the plague bacilli on an earth and cow-dung floor must ordinarily be entirely different from the disposition of the plague bacilli in Dr. Marsh's experiments. This will be manifest when we consider that under natural conditions the large majority of the plague bacilli will, unless the floor material has been renewed, be found on the surface of the floor, or in cracks which directly communicate with the surface. The majority of the plague bacilli being thus disposed will of necessity come in contact with the disinfecting solution before any of the less exposed portions of the floor. Hence, even if they have, as compared with cow-dung, less chemical affinity for the disinfectant, they will, owing to their position, which secures that they shall be more fully exposed to the disinfectant, be more likely to be acted upon by it.

18,829.
18,838.
II. 10.

For the reasons that have just been given, we may put on one side Dr. Marsh's very careful experiments, as experiments which do not resolve the practical question which is here at issue, as to what is the minimum concentration of perchloride of mercury which will suffice to bring about the desired disinfection.

(*b*) Test of effectiveness of a disinfection process by comparing number

651. We have now to pass on to consider the next of the methods of experimentation which have been referred to above. In the case of the experiments which we have now in view (and such experiments have been undertaken both by Mr. Hankin

of bacteria obtainable from the floor material before and after disinfection.

and also by Dr. Marsh), an endeavour was made to judge of the efficacy of various disinfection processes by making comparative enumerations of the number of bacteria which are present in a floor before and after disinfection.

Mr. Hankin's experiments.
8552 (II., 10–13).

With regard to the particular procedure which was adopted by Mr. Hankin in his experiments, we may observe the following points. The quantity of floor material which was employed for his bacterial enumerations was not measured in any accurate manner. That quantity was, Mr. Hankin says, "as much as could be taken up on the end of a flattened needle." Further, it is to be noted that the number of colonies which appeared in the plate cultures was, as is pointed out by Mr. Hankin, influenced to a very considerable extent by the moister or dryer condition of the floor material. When the material of the floor was dry it did not break up readily in the nutrient medium. Hence the dryer floor material yielded relatively fewer isolated colonies than the wetter floor material which broke up more readily. It is obvious that experiments, into which such serious sources of error as these have been admitted must be accepted with a great deal of reserve. Indeed, Mr. Hankin himself does not claim for his experiments any absolute value. He claims only that results of such experiments would be of "some relative value if repeated sufficiently often." In conformity with these considerations we shall, in appreciating the experimental data with which Mr. Hankin has furnished us, do well to leave out of view the discordant and paradoxical results of certain individual experiments, and to take into consideration only the results which repeat themselves over and over again in the course of his experiments.

Proliferation of bacteria surviving the process of disinfection renders the above test untrustworthy.

652. It would appear that a somewhat complex effect is exerted upon an ordinary earth and cow-dung floor by the application of a disinfecting solution. The first effect apparently consists in a diminution in the number of bacterial colonies which can be obtained from the floor: this effect is no doubt directly referable to the bactericidal action which is exerted by the disinfectant. Supervening upon this, there would appear to be a secondary effect in the form of an increase in the number of bacterial colonies: this last effect would appear to be attributable to a proliferation in the moistened earth and cow-dung floor of the bacteria which have survived the process of disinfection.

It will be manifest that the occurrence of such a secondary increase in the number of bacterial colonies is a phenomenon which will, if it occurs early, and if it occurs to any appreciable extent, make it impossible to place any confidence in any results which have been obtained by the method of enumeration. Now, it would appear, if we may accept as accurate the experimental data given by Mr. Hankin, that, though the maximum diminution in the number of the colonies is, in some cases, found only after the expiration of two hours, the secondary increase in the number of colonies may already have become noticeable after the expiration of only half-an-hour. Again, it would appear from the experimental data furnished by Mr. Hankin that the number of colonies found after disinfection may, in some cases, greatly exceed the original number of colonies found before disinfection. As an example of this, we may refer to experiments made by Mr. Hankin to ascertain the disinfecting effect exerted on a mud and cow-dung floor by a 1 per 1,000 solution of perchloride of mercury, a 1 per cent. solution of chloride of lime, a 1 per 500 solution of sulphuric acid, a 1 per cent. solution of phenyle, and a 1 per cent. solution of lysol, respectively. The excess of the bacterial colonies found after the use of the disinfectants enumerated above was, as compared with the number of bacterial colonies originally obtained, represented by 30 per cent., 215 per cent., 200 per cent., 38 per cent., and 120 per cent. respectively.

8552 (II., 11).

It will thus be obvious, that even if we could leave out of consideration the serious causes of error which, as we saw above, are attached to the experimental procedure adopted by Mr. Hankin, the fallacies which result from secondary proliferation of the surviving bacteria are of themselves quite sufficient to render the method of enumeration an untrustworthy method of gauging the efficacy of a disinfection process, or the relative efficacy of two different disinfectants.

But conclusions as to the effectiveness of certain disinfectants can legitimately be arrived at by this test.
8552 (II., 11).

653. While we desire to emphasise this point, we are of course ready to admit that where a very striking diminution of the numbers of bacterial colonies has been obtained after the employment of a particular disinfectant, it will be possible to assert with confidence that the disinfection process which has taken place has been an effectual one. To take an instance, we may legitimately draw a conclusion as to the effectiveness of the disinfectant employed from such results

as were obtained by Mr. Hankin from two portions of a floor which had been disinfected (in the one case with a solution containing 1 in 1,000 of perchloride of mercury and 1 in 500 hydrochloric acid, and in the other case with a solution containing 1 per cent. of sulphuric acid and 1 per cent. of permanganate of potash). Here, 24 hours after disinfection, the number of colonies found in the disinfected floor was represented respectively by 1 per cent. and 7 per cent. of the original numbers. A similar conclusion as to the efficacy of the disinfectant employed may be drawn from results obtained by Dr. Marsh. In an experiment recorded by this 18,862.
observer, the number of colonies obtained from the disinfected floor was represented by only 6 per cent. of the number present before disinfection. On the other hand, —and this clearly exhibits the difficulty of drawing a definite conclusion from the method of enumeration—we are left in doubt whether a reduction of 65 per cent. in 18,816.
the number of colonies, such as was obtained by Dr. Marsh in another experiment, can be considered as conclusive evidence of the effectiveness (*quo-ad* the destruction of plague bacilli) of the disinfection process which was there employed.

(c.) Method of judging of the effectiveness of disinfection processes by consideration of the nature of the surviving bacteria. 26,434A.

654. In view of the above, some better method of determining whether a disinfection has or has not been effectual, appeared to be urgently required. It was manifest that such a method could be obtained only by substituting a qualitative for a quantitative test to the bacteria which are obtained from the floor after the completion of disinfection. We have made some preliminary experiments in the direction of elaborating such a method. In the experiments in question, we have taken it as an axiom that, if all the species of micro-organisms, recovered from a floor which has undergone a disinfection process, are micro-organisms which present a considerably greater resistance to the particular disinfectant employed than the plague bacilli whose devitalisation is aimed at by the disinfection, then this disinfection must be regarded as having effected the devitalisation of any plague bacilli which might have been present in that floor.

Details of method employed in our experiments.

The details of the method which we employed are as follows. Samples of the floor material which has undergone a disinfection process were collected. The samples, inasmuch as they were to serve only for the determination of the varieties of micro-organisms which might survive the disinfection process, were not measured in any way. What was actually done was to collect a little material by rubbing in each case a sterile cotton-wool plug, extracted with antiseptic precautions from a sterile test-tube, here and there over the floor or wall which was to be tested. This done, the plug was replaced, and the samples thus collected were conveyed to the laboratory. When the examination was taken in hand, a small quantity of each soiled cotton-wool plug was placed in a tube of nutrient broth. Care was taken to employ a relatively large quantity of this nutrient medium so as effectually to dilute any disinfectant which might be carried over. This precaution having been taken, the tubes of broth were incubated for 24 hours. In cases where the tubes, after this interval, showed any signs of growth, isolated colonies of the various bacteria were obtained. This was for the most part done by making zigzag cultures on agar. Pure cultures of any bacteria which survived the disinfection process having thus been obtained, graduated dilutions of the disinfectant which was employed in the disinfection process were prepared in a series of test-tubes. As many series of such tubes were employed as there were species of bacteria to be tested. Into each dilution of the disinfectant was introduced a sufficiency of these pure bacterial cultures. After an interval of 15 minutes, a loopful was taken from each solution of the disinfectant which had received a portion of the pure culture of the bacteria recovered from the disinfected floor. This loopful was transferred to a tube of nutrient broth which was incubated at the temperature of the room. By this means information was obtained as to the capacity of the bacteria which were recovered from the disinfected floor for resisting the action of the disinfectant. This resisting power was then compared with the resisting power of the plague bacillus when subjected in similar manner to the action of the same disinfectant, and in cases where the resisting power of the last was found to be very distinctly less than the resisting power of each of the various species of micro-organisms which were recovered from the disinfected material, the disinfection was assumed to have been adequate.

Results of our experiments.

In the experiments which were instituted by Lieutenant Liston, I.M.S., under our direction, with a view to determining by this method the adequacy of a series of disinfections which were done in the Mandvi quarter of Bombay with a 1 in 500 solution of perchloride of mercury, it was found in one case out of seven that the material obtained from the paved or cemented floors which were tested was completely sterile. In the case of two other floors the only growth obtained was a growth of moulds. In the case of the four other floors the cultures gave bacterial growths. When the resistance of these last to perchloride of mercury was tested, it was ascertained that the bacteria, which had survived the disinfection, were all (except in a single instance where one of the micro-organisms which was recovered possessed a slightly less power of resistance) able to resist an exposure of 15 minutes to a solution of perchloride of mercury of a strength of 1 in 1,000. Plague bacilli tested in a similar manner in no case survived an exposure of 15 minutes to a solution of 1 in 5,000 of perchloride of mercury. It would thus appear that the particular disinfections whose efficacy was tested by this method were perfectly adequate.

Probable utility of above method.

The information which is obtained by this method with regard to the efficacy of a disinfectant may appear to be gained by a somewhat laborious method, but we foresee that a bacteriologist who was occupied in such work would very soon possess a knowledge of the bacterial flora of the locality in which he was working such as would enable him to judge at a glance of the efficacy of the disinfectant by noting the morphological characters of the colonies of the bacteria obtained from the disinfected material. It seems to us that by some such system of bacteriological examination as that which has been outlined above, it would be possible not only to determine in any particular case the efficacy or otherwise of a particular disinfection, but also that it would be possible to determine for general guidance not only the question as to which is the most effective disinfectant, but also the question as to the minimum strength of that disinfectant which would be effective.

III.(4.)(*c.*) *Efficacy of Burning, Heat, and Steam, as Disinfectants for Plague.*

Disinfection by the agency of heat.

655. We may now pass from the consideration of the principles of chemical disinfection to consider the general question of disinfection by heat.

In connexion with the application of heat to the sterilisation of plague-infected objects, we may consider here the application—

Firstly, of the extreme temperatures which are developed in a flame;

Secondly, of dry heat, meaning thereby temperatures short of the charring point;

Thirdly, of temperatures ranging from 100° C. upwards to 130° C., or thereabouts, such as those which are developed when water is vaporised in a closed vessel under pressure of a few atmospheres; and

Fourthly, of temperatures of 60° C. to 100° C., such as those which are obtained when water is heated in open vessels.

Conditions under which different methods of disinfection by heat are appropriate.

656. Stated generally the destruction of objects by burning is a method to be resorted to only where there is difficulty in insuring that the whole of the infected material shall be adequately disinfected by other means.

Of quite exceptional application is, also, the agency of dry heat, in the form of temperatures short of the charring point. It will suffice, since the influence of dry heat below 100° C. will come into consideration in connexion with the discussion of the influence of desiccation, here to consider the influence of the application of temperatures between 100° C. and 200° C., when charring may be said to begin. With regard to the effect exerted by such temperatures on the vitality of the plague bacillus, information is afforded by the experiments of Gladin. This observer found that the vitality of the plague bacillus was destroyed in 20 minutes by an exposure to a temperature of from 100° to 110° C., in five minutes by exposure to a temperature of from 130° to 140° C., and in one minute by an exposure to 160° C. It will thus be seen that when the agency of dry heat is employed, the destruction of the plague bacillus is rapidly achieved only at temperatures approaching the charring point. It is, therefore, manifest that the agency of dry heat is not a convenient disinfecting agency for employment in ordinary life.

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Where the agency of moist heat is to be brought into application as a disinfectant, our choice will lie between the employment of temperatures ranging between 60° C. to 100° C. and the employment of temperatures ranging between 100° C. and 130° C. Before considering the various methods which may be adopted for bringing these temperatures into application, we shall do well to place before ourselves the following facts:—

(*a.*) The plague bacillus is killed instantly at a temperature of 100° C. and, of course, at all higher temperatures.

(*b.*) The plague bacillus is killed after an exposure varying from a quarter of an hour to a few seconds when it is exposed to temperatures between 60° C. and 100° C.

It will be manifest from this that so far as the efficacy of the disinfection is concerned, the temperature which is developed when water is boiled in an open vessel is amply sufficient for the instant sterilisation of plague-infected objects. Briefly stated, the conditions under which an advantage will accrue from the use of the higher range of temperatures which can be obtained by means of steam generated under pressure are limited to cases where objects would be destroyed by immersion in boiling water, and to cases such as that of the disinfection of the personal effects of travellers, where the subsequent drying of the disinfected articles would entail delay and discomfort.

In view of the fact that these inconveniences can be avoided when disinfection is done by steam under pressure, we may briefly consider the different modes in which steam under pressure is brought into application for disinfecting purposes.

Methods of applying steam under pressure for disinfection purposes.

657. It must be distinctly understood that the temperatures which are associated with the use of steam under pressure are not in all cases brought into effective operation in steam sterilisers. When tight bundles of clothes are introduced into such sterilisers, and when steam is admitted into the disinfecting chamber merely to be shut off after the chamber has been filled (this is an arrangement which was adopted in many extemporised steam disinfectors in India), the pressure, and in correspondence with this the temperature, of the steam may be reduced, by condensation on the outside of the bundle, until it entirely ceases to be effectual. Again, even where the pressure of the steam is continuously kept up in the disinfecting chamber, the heat, though well kept up in the disinfecting chamber as a whole, may none the less, owing to the fact that the air has not been displaced, fail to penetrate into the interior of the bundles of clothes.

Precautions against failure, due to this last cause, are therefore taken in all the more modern patterns of steam sterilisers. In some of these the steam as it is given off from the boiler is sent into the disinfecting chamber, and is allowed to issue thence in a continuous stream through a safety valve. It is intended that the steam which is thus passed through, shall evacuate all traces of air from the interior of the clothing in such a manner as to permit the heat diffusing itself throughout the whole mass. It would, however, appear that this expectation is not always fully realised. The steam will, in many cases, since it will follow the most unhindered path, find its way to the escape only through the larger vacant channels left between the bundles of clothes. In consequence of this, the air will only be very slowly evacuated from the interior of the clothing, and in correspondence with this the heat will take a long time to penetrate.

Another, and a more effective, method of achieving the desired evacuation of the air, is to fit the steam steriliser with an arrangement which allows of the disinfecting chamber being evacuated and refilled with steam several times in succession. By this procedure the air is drawn out from between the interstices of the clothing, with the result that the hot steam is enabled to penetrate rapidly.

In view of the above, it will be readily understood that effectual disinfection by steam under pressure can be ensured only when clothes are thoroughly opened up or when steam sterilisers are employed which allow of the air being effectively evacuated from the interior of bundles of clothing. It will be wise always to control the working of the steriliser by placing a maximum thermometer (preferably a signal thermometer) in the interior of the bundles of clothing. To secure that attention shall be given to these essential points, it will be necessary in all cases to commit the working of the steriliser to a skilled and trustworthy operator. Where such an operator cannot be secured, we think that steam sterilisers are likely, in practice, to be found quite ineffective.

III.(4.)(*d.*) *Efficacy of Direct Sunlight as a Disinfectant for Plague.*

Disinfection by exposure to the direct action of the sun.

658. We may next turn our attention to the disinfecting agency of the sun. A sufficiency of experimental data is available to enable us to form some judgment of the influence which is exerted by the direct rays of the sun upon the vitality of the plague bacillus. Experiments on this question have been instituted, among others, by Kitasato, by Wilm, by Abel, by the German Plague Commission, and by ourselves.

It is clearly brought out by the experiments in question that direct sunlight, both in India and in temperate climates, exerts a very considerable devitalising effect on the plague bacillus, more particularly where the culture which is exposed to the rays of the sun is spread out a very thin layer. In such circumstances it was found that exposure for one hour to the sun's beams sufficed to devitalise the plague bacillus. When the bacillus was spread out in thicker layers the sun's rays took much longer to effect their object. Naturally the time required for the devitalisation is longer when the plague bacillus is covered up in any way. The German Plague Commission found that the bacillus, when incorporated in wool and exposed to sunlight, maintained its full virulence after eight hours' insolation. The experiments which were made by ourselves are detailed in the evidence of Lieut. H. J. Walton, I.M.S. We, like the German Plague Commission, found that agar or broth cultures of plague preserved their vitality after exposure to direct sunlight for three hours. It was, however, noticed, that when subsequently to insolation the contents of the test tubes were inoculated on new culture media, the growth of plague was very much retarded, the first signs of growth making their appearance only after the fifth day instead of on the first day. Plague cultures on agar and broth were not finally killed off until after an exposure of four hours to the direct light of the sun. When spread on loosely woven calico the plague bacillus was killed off by a three hours' exposure to sunlight, even when it was covered up by as much as six layers of the same material. On the contrary, the sun's rays did not exert any disinfecting action even in 3½ hours through a single fold of flannel. Again, in another experiment done with the hemmed margin of an ordinary pocket handkerchief, plague could be recovered by cultivation after exposure to strong sun light for three hours. In this experiment the growth was, however, very considerably retarded. Lastly, in an experiment in which thin twisted wisps of cotton-wool, which had been infected with plague, were exposed to the sun's rays, it was found that a three hours' exposure did not suffice to devitalise the plague bacilli. 26,342-6.

We were on no occasion able to observe that any growth-retarding or devitalising action was exerted on the plague bacillus by the action of diffused daylight.

III.(4.)(*e.*) *Efficacy of Desiccation as a Disinfectant for Plague.*

Disinfection by desiccation.

659. A great number of observations have been made by Kitasato, Wilm, Abel, and the German Plague Commission, to determine the effect which is exerted upon the plague bacillus by desiccation. The more important results of these experiments may be summarised as follows:—Desiccation exerts a devitalising effect upon the plague bacillus which is proportionate to the degree to which the desiccation is carried. This last is determined on the one hand by the degree of humidity of the air, and on the other hand by the degree to which the bacilli are exposed to, or sheltered from the desiccating influence of the air. In ordinary circumstances the humidity of the air will be influenced more than by any other factor by the factor of temperature, and the degree to which the bacilli are exposed to the desiccating influence of the air will depend in great measure upon the nature of the material with which they are incorporated.

Period of survival under desiccation under different conditions.

The influence of the temperature is clearly brought out by Abel's experiments, plague bacilli desiccated at a temperature of 35° C. being devitalised in two to three days, whereas plague bacilli desiccated at 16° to 20° C. survived six to nine days.

The influence of the material with which the plague bacillus is incorporated is shown in the experiments of Abel and others by the fact that the plague bacillus when included in woollen, silk, or other fibre, or in pieces of infected organs, has a much longer period of survival than when it is disposed on the surface of non-porous objects. This result is probably in the main referable to the mechanical protection from desiccation which is afforded by the materials in question to the plague bacilli in their interstices. It is, however, quite possible that the water-retaining properties of the materials themselves may also come into account.

With a view to appreciating the application of these principles, we may consider what the actual period of survival is when the plague bacillus is placed under certain definite sets of conditions. We may take first the case of a plague culture which has been spread out in the form of a thin film on the surface of a coverglass, which is placed in a desiccator over sulphuric acid or calcium chloride. In these circumstances, both in Wilm's experiments and in our own, the plague bacillus survived only a very few hours. We may pass from this to the case of plague bacilli incorporated in silk, wool, or other fibre, and subjected only to such desiccation as will occur at a temperature of 18° to 25° C. under ordinary atmospheric conditions, and for the most part in the dark. Information regarding the period for which the plague bacillus can survive under such circumstances is available from several sources. We have an experiment of the German Plague Commission showing that the plague bacillus may survive under these conditions for 28 days. We have, further, experiments by Forster, Löffler, and Gladin, which show that the plague bacillus may survive when dried on silk, wool, and cotton cloth, for as long as 45, 56, and 76 days respectively. Lastly, we have an experiment carried out by ourselves under these conditions, in which the plague bacillus was found to survive on calico for a period of 70 days. Long periods of survival have also been observed to occur in the case of plague bacilli incorporated either in

Report of German Plague Commission, page 277.

Centralblatt für Bacteriologie, December 20th, 1899, page 722.

albuminous discharges, or in the organs of animals dead of plague. A reference may here be made to the experiments of Katzarof, and to those of Gladin, who showed that the plague bacillus retained its vitality for 16 to 36 days in the organs of plague-infected animals. Finally, we may consider what the period of survival has been in the case of experiments performed under the atmospheric conditions which obtain in the fair weather in Bombay. The data upon which we can draw for information with regard to the behaviour of plague in these conditions are the data of the experiments made by the German Plague Commission at Bombay, and the data of a few similar experiments instituted there by ourselves. It was found in the experiments of the German Commission that the devitalisation of the plague bacillus even when it was incorporated in woollen or other textile fabrics or in albuminous discharges was in every case effected within eight days. The few experiments which we made gave us very similar results. The longest interval after which we recovered the plague bacillus was seven days. This was in the case of a gunny bag which had been artificially infected with plague. In the case of grain artificially infected the bacillus was not recovered by us after seven days, though it was recovered on the third day.

Loc. cit.

26,344–6.

26,386.

Remarks on period of survival of plague under desiccation in Bombay.

The results of the experiments done in Bombay would appear to be very important results because of their application to India. But it must be borne in mind that they relate only to plague bacilli disposed on the surface of non-porous objects, and to plague bacilli disposed on threads, or on comparatively small pieces of various fabrics fully exposed to the air. Now these manifestly are conditions which only rarely obtain in actual life. And where objects are piled up one on the top of the other, and generally where large masses have to be dealt with, effectual desiccation may quite well be a much slower process than it was in these experiments. Moreover, these experiments will not afford any basis for an estimate as regards the period for which the plague bacillus can survive in colder, and at the same time moist, climates; and in our consideration of Mahamari, we have seen that there are facts which suggest that the plague bacillus may survive in Kumaun and Garhwal for months, if not for years, outside the animal organism.

Para. 375 of this Report.

III.(4.)(*f.*) *Efficacy of Ventilation, Cleansing, and Washing, as Disinfectants for Plague.*

Disinfection by ventilation, and by ordinary cleansing and washing.

660. There is but little to be said about disinfection by ventilation and by ordinary cleansing and washing. The following remarks are all that seem called for. The mere admission of air into an infected house or room cannot be expected to bring about the devitalisation of the plague bacilli which exist there. Ventilation, however, operates as a disinfecting agent in so far as the currents of air which are set up conduce to the desiccation and to the mechanical removal of the infected material. In conformity with this a sharp distinction must be drawn between mere admission of air and ventilation. Manifestly, cleansing and washing are effectual only in so far as they mechanically remove infected material.

III.(4.)(*g.*) *The Crowding Out and Destruction of the Plague Bacillus, without Special Measures of Disinfection, by the overgrowth of Saprophytic Bacteria.*

Disinfection by the crowding out of pathogenic germs in the struggle for existence by the overgrowth of ordinary saprophytic bacteria.

661. We may next consider the question of the crowding out of pathogenic germs in the struggle for existence by the overgrowth of ordinary saprophytic bacteria. This disinfecting agency, which is continuously and everywhere at work in nature, may be regarded as one of the most important of all the disinfecting agencies which operate in the direction of destroying pathogenic bacteria. How greatly the growth of the plague bacilli is, in external nature, hampered and checked by competition with the ordinary saprophytic organisms which lie about everywhere, will be best appreciated when we place before ourselves the extent to which these organisms effect the growth of plague in cultures. When a plague culture has been contaminated with any considerable number of the common saprophytic bacteria, it becomes, owing to the more luxuriant growth of these last, a matter of the very greatest difficulty to recover the plague bacillus by cultivation from the impure culture. It would even appear that certain saprophytic bacteria, and notably, as pointed out by Bitter, the bacillus coli communis, which is invariably found in fresh cow dung as well as in excreta of other animals, and, according to Gladin, also the micrococcus prodigiosus, the bacillus subtilis, and certain pathogenic micro-organisms, exert a direct restraining influence on the growth of the plague bacillus. We were able to obtain some evidence of the restraining influence which is exerted by the toxins of the bacillus coli communis on the growth of plague. The experiments in

26,341, 26,391.

Bitter, Report on Plague in Egypt, p. 52.

Centralblatt fur Bacteriologie, 1898.

26,150.

question will be found detailed in the evidence of Capt. Spencer, R.A.M.C. Facts of this sort are of capital importance, inasmuch as they seem to indicate, and the indications in question are borne out also by practical experience, that uncleanly houses do not necessarily, when infected, become hotbeds of plague. Again, in this connexion it may be well to keep in view the fact that the sweepers of Bombay who deal with all the excreta of the plague-infected city, were for a long period almost free from plague. Up to the date of our departure from India they seem from the point of view of their liability to contract plague to have compared favourably with the rest of the community. These facts may perhaps be to some extent accounted for by the processes of self-disinfection which take place in infected filth.

Para. 306 of this Report.

Having thus placed before us the general principles of disinfection, we may proceed briefly to review what has been done in the way of disinfection in India. We may first consider the disinfection of houses.

III.(1.)(*h.*) *Measures of Disinfection which have been applied to Houses in India.*

Measures of disinfection which have been applied to houses, and extent to which these measures have been employed.

662. The disinfection of houses was one of the earliest plague measures adopted in Bombay City. It has throughout been vigorously resorted to. In the earlier period phenyle and permanganate of potash solutions were the disinfectants which were most largely employed. In addition sulphur fumigations were at this period carried out in the streets and houses; tons of carbolic acid were poured into the sewers; and in certain instances the drain pipes were taken down from the houses and were steeped in hot water. Chloride of lime, and creosote and carbolic powders, were strewn about without system; whitewashing was superadded to the chemical disinfection, and the houses were, after disinfection, vacated for a considerable period. At one time a system was in vogue by which houses situated on the line which plague was expected to follow were whitewashed in advance, this measure being in some cases confined to the outside of the houses. Infected houses were also, in some instances, burned down. In many cases they were completely or partially unroofed. In combination with these last measures, a system was largely adopted of breaking holes in the partition walls between the different rooms in the overcrowded chawls. Obstructions were removed from the verandahs. In some cases ventilation was further improved by making holes in the floors and ceilings, so as to allow a current of air to pass up through the buildings. Many of these measures have now been abandoned. Chemical disinfection of the houses is now carried out with a solution of perchloride of mercury in hydrochloric acid. Whitewashing after disinfection has been largely given up, and the people are now allowed to return to their houses as soon as these have been disinfected. With regard to non-chemical methods of disinfection, it will suffice to note that, with a view to admitting "light and air" to the houses, a process of partial unroofing is largely resorted to, not only in the case of infected houses, but in the case of insanitary houses generally. Further, the pipe water supply has been cut off from the interior of the houses. This last has been done with a view to diminishing the dampness which arises from the disposition of the natives to leave water taps running.

The measures of house disinfection adopted in Bombay City were, speaking generally, adopted also in other towns. We may note, however, as a point of difference that in Hubli the very drastic measure of burning down a whole street was resorted to. Further, we may note that in some places the process of kiln burning the floors, which is described below, was resorted to in conjunction with or in lieu of the process of chemical disinfection.

1645, 1954.

Para. 665 of this Report.

In the case of villages several different lines of policy were adopted. In some cases chemical disinfection, whitewashing, opening up, and keeping the houses unoccupied, were all carried out. In other cases chemical disinfection was omitted and the houses were merely opened up and vacated. Again, in widely infected tracts like the Mysore State and the Deccan districts of Bombay, where there were scores of infected villages, systematic measures of disinfection were impossible; and little could be done beyond encouraging the people to clean out their houses, to keep them vacant for some time, and to make ventilation openings in the roofs. In the Hyderabad State, in the second year of the epidemic, the kiln-burning of the floors was resorted to, to the exclusion of all other measures.

3324, 2145-6, 24,037.

5443-9, 5846.

Just as there were differences in different places with regard to the measures of disinfection which were applied, so there were differences with regard to the extent to which the infected houses were brought within the scope of the disinfecting operations. It will suffice to refer to a few points in illustration of the different practices which have been pursued in different places. In Bombay City the practice, 25,640. in the case of chawls, has been to disinfect the two rooms on each side of that occupied by the plague patient. In Calcutta, disinfection is restricted to the room which 6591. is inhabited by the plague patient. In Baroda, disinfection was applied to every 14,631. house to which a death of any kind could be traced. Disinfection, *en bloc*, was resorted to in the case of the combined towns of Hardwar, Kankhal, and Jawalapur. 9045, 9115, 9175. Here the entire towns appear to have been disinfected house by house, and room by room. Similarly, in villages where chemical disinfection was undertaken, the village was disinfected from end to end.

Agency employed for disinfection of houses.

663. The agency which was employed for the disinfection of houses may with advantage be considered next. In a few places, as, for instance, in Bangalore and in the Bellary district, native soldiers were employed as disinfectors. In other places, as in Karachi, the disinfection of the houses was committed to the house-owner, the Municipality finding the disinfectant; but this was a more or less exceptional practice. Generally, however, throughout India the disinfection was done by gangs of coolies specially engaged for the purpose, with a native overseer at their head. Wherever possible it was arranged that the work of the disinfecting gangs should be supervised either by Hospital Assistants, or, where such were available, by British soldiers. The general supervision and initiation of the disinfecting arrangements was in most 7971–6. cases committed to the British Staff Corps officers who were employed on plague duty. Only in a very small proportion of cases were the disinfecting arrangements directly supervised by anyone, medical or lay, who had any special scientific training or any previous experience of disinfecting operations.

"Flying columns."

In connexion with the agency employed on disinfection operations mention deserves to be made of the system, initiated by the Surgeon-General with the Government of 16,992, 17,158–9. Bombay, of providing, with a view to their being sent to newly attacked places, trained 21,618–29. gangs of disinfectors, with a regular equipment of wooden pumps and other implements and a supply of disinfectants. The constitution of these "flying columns," as they were called, was in intention as follows. The column was to be placed in charge of a Commissioned Medical Officer or other English doctor. Two native Medical Assistants, and, where possible, also a female Hospital Assistant, were to be provided. The working staff was to consist of a couple of native overseers and 20 or 30 coolies recruited from among the disinfecting gangs employed in Bombay City. In actual practice, as soon as notice was received from a Collector of the occurrence of a new outbreak of plague, a column was despatched ready to begin work at once, and to serve as the nucleus of a larger establishment. It was naturally impracticable, with plague spreading everywhere, to supply anything like the intended staff. In many cases it was impracticable to send even a medical subordinate of any kind.

Procedure adopted in chemical disinfection of houses.

664. The actual process of house disinfection, to take the particular case of the Punjab, where disinfection appears to have been very scrupulously carried out, is thus described by Captain James, I.M.S., who was in charge of the operations :—

"The disinfecting gang was collected in the street near the house, and all the materials required were placed in readiness in some convenient open space, if possible, 10,015. near the centre of the area to be dealt with. The owner of the house was brought in by the Hospital Assistant or the constable from the camp where he was living, and allowed to open the lock of his door, and then made to sit down in the street, somewhere where he would not be in the way, and where he could watch all that was being done to his house and property. But he was not allowed to take any active part in the disinfecting or to enter any of the rooms till they had been disinfected. With pumps and syringes a stream of antiseptic solution was made to play on the closed doorway till the woodwork was thoroughly wet. It may seem unnecessary to begin using the antiseptic so soon, but the object was to impress the workers that they had to deal with infected places, and it was necessary to teach them thoroughness from the very commencement and to insure the good work, without which the object for which they strove would not be obtained. The door was then thrown wide open, and before anyone was allowed to enter a stream of antiseptic was made to play over as much of the interior of the room as was visible from outside. Thus the dust inside was laid, and it was fairly safe for persons to enter. The pump-men then went inside and from the centre of the room continued the pumping till every part of the ceiling, walls, and floor were wet and running with antiseptic solution. Other coolies now entered and carried out into the open every piece of furniture or movable property, while they were still wet with the lotion, and placed them either in the roof in one corner or in some convenient place in the yard, or even in the street, where they could get the full benefit of the direct rays of the sun. All rubbish, rags, or articles of no value to the owner were taken out into the open and burned. Small articles were dipped bodily in vessels containing antiseptic fluids which were kept in readiness near the doorway. The owners were encouraged to take as much as possible of their property away into their camps after it had thus been thoroughly disinfected. We found this necessary, because when people went out hurriedly into camp, afterwards they found they wanted things. The Hospital Assistant and the disinfecting gangs and officers were all present, and we could disinfect their articles and let them take them out with them. Corn, seeds, flour, turmeric, and such articles which would be spoiled by placing in water were spread out in the sun for a day; the vessels which had contained them were disinfected *secundum artem*, and, when dry, the various materials were returned. Books and manuscripts were also exposed to the sun's rays. . . . . . The dry places, left by removing articles from the room, were at once tackled by the pump-men, who directed a jet of antiseptic towards every space thus left undone. In the same way, articles removed were subjected to a thorough drenching with antiseptic, when they got outside."

The process of chemical disinfection which is here described, with the difference that in most places perchloride of mercury took the place of the phenyle solution, was also the procedure which was adopted throughout India. In particular, the practice of pumping, or, where pumps were not available, of throwing the disinfectant over the walls, appears to have been everywhere adopted.

Method of kiln-burning floors.

665. As a substitute for the process of chemical disinfection described above, the process of "kiln-burning" the floors of infected houses was, as we said above, in some instances resorted to. This was notably the case in the Hyderabad State. The following description taken from a memorandum prepared by H. H. the Nizam's Deputy Plague Commissioner will give an idea of how this kiln method was carried out.

I. 456.

"The surface of all floors, and the lower portion of walls two feet from the floor surface is first to be painted over with rather thick limewash and allowed to dry. This serves two useful purposes. (1) It lays the dust, and thus lessens the risk of inoculation to the coolies working in the house; and (2) it colours white every part of all surfaces that have to be removed and burnt. The whitened surface is easily seen, and there is little or no chance of any portion of the infected earth remaining behind and being left unburnt. While the lime-wash is drying on the surface, the foundation or floor of the kiln in which the surface earth is to be burnt, should be laid. The kiln should be made in any sufficiently large sized courtyard, garden, or open space in or near the house, or the road or pathway immediately facing the front entrance of the house can be used. A circular kiln will be found the most convenient in shape. The floor of the kiln is made of two layers of "ooplies" (cowdung cakes), four inches deep, laid flat, and packed closely together. The mud floor of the infected house should be carefully dug out to the depth of 1½ inches from every room, verandah. and yard which has been whitewashed, and filled into iron baskets, or empty kerosine oil tins, if possible, without spilling or raising any dust. The dug out earth should now be carried to the kiln and evenly spread over the "ooplies," which form the floor of the kiln to a depth of 1½ inches. This, the first layer of infected earth is then completely covered with a layer of "ooplies," 2 inches deep, upon which a second layer of earth is spread and covered with "ooplies," then a third layer of infected earth, and so on, with alternate layers of infected earth and "ooplies" until the kiln is complete. One and a half to two feet is the best height for a kiln. Lastly, the kiln is covered in from top to bottom with two layers of "ooplies." It should then be fired at the base, and allowed to slowly burn itself out, a process that usually takes about 48 hours. It is, however, advisable not to disturb the ashes of the burnt kiln for a week, as it continues to smoulder for about that time. When the kiln has cooled down, it should be opened in one or two places and examined, and, if found completely burnt out, the ashes should be removed to cultivated lands and used for manure. The entire limewashed surface of the infected floors having been dug out and burnt in the kiln, all that remains to be done to the infected house is to fill in the empty floor space with fresh field earth, moisten it with water, and consolidate it by ramming; subsequently, mud-plastering, or "leeping" it. Finally the new floor surface and walls should be well drenched with perchloride of mercury solution of the strength 1 to 1,000 parts of water. The house is now perfectly disinfected, and as soon as the floors have dried it is fit for occupation."

Methods of opening up the houses to sun and air.

666. The methods which were adopted in opening up the houses differed in different places. In some cases, as has been said above, the houses were completely unroofed, the walls alone being left standing. This radical measure was, however, comparatively seldom resorted to. In Bombay City, as we have already seen, and in other towns, the system that was most commonly adopted was that of taking off alternate rows of tiles, and of stacking these up upon the top of the rows which were left in position

In the case of the villages, as a substitute for complete unroofing, the general custom was to make an opening through the thick mud roof, so as to admit "light and air" into the windowless inner room of the village house. The result achieved of course varied with the size of the opening which was effected. In many cases openings were so made as to admit a considerable amount of sunlight; in some cases a mere pencil of light was admitted into an otherwise perfectly dark room. Occasionally the hole which was broken in the roof was supplemented by a window broken in the wall. In most cases the principal room of the village house was not interfered with, light and air being assumed to come in in sufficiency through the doorway.

Attitude of the people towards the measures of disinfection which have been applied to their houses.

II. 362 (262).

667. The general attitude of the people towards the measures of disinfection which have been applied to their houses has been an attitude of resignation. In the recently infected parts of India, no instance has been brought to our knowledge similar to those which have been reported from plague-stricken villages in the district of Kumaun and Garhwal, where the people after their long and bitter experiences of plague have begged the authorities to proceed to the extreme measure of burning down the infected houses. The nearest approach to a recognition of the advantages of applying measures of disinfection to their houses is, perhaps, to be found in the fact that when Lieut. Thomas placed a premium on disinfection by making a charge for the labour and a further charge for the disinfectant, the inhabitants of Hubli were willing not only to pay these charges, but also to vie with their neighbours in incurring extra expense for additional disinfectant. This statement is, however, to be taken in connexion with the fact that we are told of these same inhabitants of Hubli, that they had been bribing the coolies to write up disinfected on their houses and to go away and leave them alone. However this may be, we are told of the closely adjoining town of Dharwar that the people probably did not believe in disinfection, but applied for it "as a means of re-admission to their houses." In addition to being actuated by a natural reluctance to have their houses interfered with, the natives in India generally appear to dislike the idea of their houses being treated with "chemicals." The people had also a strong aversion to the greater interference and damage to their houses which is associated with the system of untiling and of breaking holes in the roofs and windows in the walls. The attitude of the people to the whole of such measures is clearly brought out in the fact that owing either to their desire for privacy, or owing to a feeling of insecurity which they associate with the existence of openings in the walls, or owing, perhaps, to their dislike to draughts, these openings were at the first opportunity very generally closed up again.

23,454.

23,366, 23,399.

23,776.

7520, 9740, 9893

16,137.

867, 3419, 10,271, 12,077, 19,515, 23,404, 24,203–9 24,361–2.

III. (4.) (*i.*) *Efficacy of the Measures applied in India for the Disinfection of Houses.*

Efficacy of house disinfection by fire.

668. In arriving at an opinion with regard to the efficacy of the processes of house disinfection which were carried out, it is manifest that, in addition to the experimental data already considered which bear on the efficacy of the various disinfecting agencies employed, we must take into consideration, on the one hand, the evidence which has been placed before us regarding the manner in which the different disinfecting processes were carried out in practice, and, on the other hand, the opinions formed by actual observers as to the results which were achieved by the disinfecting operations.

In certain cases, as, for instance, where the method of burning down infected houses was resorted to, a doubt as to the complete destruction of all the infective material cannot possibly arise. A doubt as to the completeness of the disinfecting process does, however, arise in cases where less radical methods of disinfection by fire were brought into use. With regard to the method of kiln-burning we may note first, that this method deals only with the germs which are incorporated with the floor, or which are to be found in the lower portions of the wall surface. We may note further that even where steps are taken to whitewash the floors and walls, there must be great difficulty in insuring the removal of all infected material. There will thus, unless the kiln-burning is afterwards followed up by chemical disinfection, be a risk of a source of infection

5449, 5851. remaining behind in the houses. It is stated, it is true, that in the Hyderabad territory no case has come to knowledge where plague has recurred in a house which has been treated by kiln-burning. But this would not be conclusive of the efficacy of the system, inasmuch as it does not appear that the people were re-admitted to their houses immediately after the kiln-burning operation had been completed.

Efficacy of the particular disinfectants in the particular strengths employed in chemical disinfection of houses.

669. Coming now to the question of the efficacy of the measures of chemical disinfection which have been so widely employed throughout India, consideration shows that the question resolves itself in every case (*a*) into a question as to whether the measures were measures which would, if properly carried out, have insured the disinfection of all the infected material, and (*b*) into a question as to whether those measures were efficiently carried out.

With regard to the efficacy of particular disinfectants and the particular strengths of disinfectants employed, there is very little in the form of fact definitely approved by experience which can be added to the experimental data considered above. That this should be so will not be surprising when we take into consideration the circumstances in which the disinfecting operations were carried out. First, we have the fact that the amounts of the disinfectants employed were only very rarely measured with accuracy. Secondly, we have the fact that the work which has to be done in a plague epidemic is so laborious that it leaves no leisure for the collection of precise data with regard to the efficacy of disinfection. And thirdly, we have the fact that in the large majority of cases, chemical disinfection was supplemented, first, by a process of whitewashing; secondly, by a process of opening up the houses; and lastly, by keeping houses empty for a considerable interval after these disinfection processes had been applied. It will be manifest that in such circumstances it is practically impossible to say how much of such success as was attained was achieved by the chemical disinfection, and how much by the subsequent processes.

Manner in which the disinfectants were brought into application in chemical disinfection of houses.

670. Passing now from the question of the efficacy of the disinfectants adopted for use to the consideration of the manner in which these disinfectants were actually brought into application, we may consider the following facts brought before us in evidence relating to perchloride of mercury which was, as we saw, the disinfectant most widely employed in India.

21,310. The perchloride of mercury employed was often very impure. For instance, in the case of the perchloride of mercury tested by Colonel Fawcett, R.A.M.C., at Poona, only 50 per cent. of its weight was soluble in water. In addition to being impure, it was,
21,307. in the particular case of Poona, where the matter was inquired into by Colonel Fawcett, found to be deficient also in point of quantity, packets of the disinfectant being issued whose actual weight was much smaller than their nominal weight. In other cases—and these were not at all infrequent—the powders of perchloride of mercury which were issued for the purpose of making up the disinfectant on the spot remained undissolved at the bottom of the tubs. This was afterwards to some extent remedied by the addition of common salt. In other cases, again, metal buckets and metal syringes were used for the preparation and application of the perchloride of mercury solutions. This must have resulted, at any rate in some cases, in an appreciable reduction of the strength of the disinfectant. With the view of preventing the waste of the perchloride of mercury thus entailed, the use of wooden buckets and Chinese pumps was introduced. We found that only in very few cases was sufficient provision made to secure that the disinfectant used should be accurately made up to the intended standard of strength. At Igatpuri the perchloride of mercury was, we were told, made
23,317. up in a strength of 1 in 10,000, in lieu of in the intended strength of 1 in 1,000. At
5100-8. Guntakal, and we have reason to believe at other places also, perchloride of mercury was mixed into the limewash, with a view to bringing both these disinfecting agents into operation simultaneously. The perchloride of mercury must have been rendered perfectly inert. With regard to the material which was employed for whitewashing we found that, owing to the fact that the disinfecting staffs did not appreciate the essential difference between caustic lime and other whitewashing materials, the whitewash often consisted either of chalk, pure and simple, or of lime which had in large part forfeited its caustic properties by prolonged exposure to the atmosphere. These errors are serious; and equally fundamental errors were committed in the case of the other disinfectants employed, particularly in the matter of making up the solutions to the required standard of strength. Such errors must have, in themselves, rendered the disinfection operations in many cases nugatory.

A source of failure, which is not of less importance, is to be found in the fact that it was in many cases practically impossible to exert anything like an effective control over the disinfectors, and to see that the procedure prescribed was actually carried out. We have already referred to the fact of the disinfectors at Hubli having been bribed to omit disinfection altogether and to mark the houses as having been disinfected. The way in which things were done at Surat—and what was done here may be taken as typical of what was done in every case where effective supervision could not be exercised—may be gathered from the evidence of Mr. Moore, the Collector. He said:—"When I was in Surat, it was my daily work to ride round the city and examine the houses which had been disinfected. I frequently found that a room had been left undisinfected, or, perhaps, the walls had been done and the floor left untouched, or the ceiling had not been disinfected, or such like omissions; parts of the house had been soaked, while the rest was comparatively dry." 7862, 21,096, 21,154, 21,174, II. 13. 24,450.

Opinion as to the efficacy of chemical disinfection of houses as actually carried out.

671. Two distinct issues arise in connexion with the question of the efficacy of chemical disinfection as applied to houses. The first is the question as to whether the application of the chemical disinfectants employed destroyed the infective material present in the house when the disinfection was undertaken. The second is the question as to whether the risk of the re-introduction of infection into a disinfected house, either, previously to the re-entry of the people by the agency of rats, or, subsequent to the re-entry of the people, by the agency of rats or men, is so great as to detract from the value of chemical disinfection as a policy. This last is a very important question which will be referred to hereafter, and here we will confine ourselves to the narrower issue of the efficiency of the processes of chemical disinfection actually carried out.

In view of the circumstance that disinfecting operations were, owing to the want of efficient supervision, often carried out in the negligent manner which we have described above, and that serious technical errors such as those adverted to above were committed in the preparation of disinfecting solutions, we have no doubt that much of the chemical disinfection done in India was inefficient. Where, however, skilled and efficient control was exercised, as in the operations carried out under the personal supervision of Capt. James, I.M.S., and other European officers in the Punjab, of Col. Fawcett, R.A.M.C., and Major Ross conjointly in Poona, and of Mr. Winter and his staff in the North-Western Provinces, we have little doubt that chemical disinfection exerted a preponderating influence in destroying the infection. It is true that in these cases measures of chemical disinfection were combined with the opening up or the prolonged vacation of the houses—both measures calculated to bring the action of desiccation and sunlight into operation. But that the freeing of the houses from infection might have been achieved independently of these measures will, we think, be clear from the following facts relating to the Punjab and to Poona. At Banga, in the Punjab, as we learn from a report by Capt. James, "In some of the larger double-storied infected houses . . . we had to trust entirely to phenyle . . . The result was quite satisfactory." (Capt. James' Report.) In Poona it was the regular practice to allow the people to return to their houses 10 days after they had been vacated. 15, 10,927–37. In view of the uncertainty of the time required for the destruction of plague infection by the agency of desiccation, this interval would, in our opinion, be probably insufficient to secure the freeing of the houses from infection, particularly in the case of houses of two or more storeys, which could not be thoroughly opened up; in fact, if we understand Major Ross correctly, the opening and limewashing of houses was found to be ineffectual when disinfection by the application of perchloride of mercury was not resorted to. 10,972.

The President does not agree with the opinion expressed in this paragraph.

For reasons stated separately,* the President does not agree with the opinion expressed in this paragraph—that "where skilled and efficient control was exercised" in the operations of disinfection, as in the instances mentioned above, "chemical disinfection exerted a preponderating influence in destroying the infection."

Efficacy of measures taken of open up infected houses to "light and air."

672. With regard to the question of the opening up of infected houses, it will be manifest that the disinfecting agencies which this opening up process is calculated to bring into operation are (*a*) the disinfecting action of sunlight, and (*b*) the disinfecting action of desiccation. We shall do well to consider to what extent these disinfecting agencies are brought into play by the opening up operations which have been described.

It will be plain that, where a house is completely unroofed, and the interior is everywhere exposed to the action of the sun and the wind, the agencies which have just been spoken of above will, in the fair weather, be brought actively into play. It is impossible to suppose that, under these combined influences, the germs of the disease could

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* *See* Appendix V.

Para. 659 of this Report.

Section VI.(6)(a.) of Chap. III. of this Report.

survive for any considerable period in a hot climate. In conformity with the experiments on desiccation and insolation which have been described above, we have reason to suppose that the germs of infection would probably all be destroyed within a comparatively few days. While this is true generally, it will be seen, by a reference to the section of our Report in which we have considered the question of the infectivity of plague houses, that there are instances on record where the infection of plague apparently persisted for three or four weeks in houses which had not only been otherwise disinfected, but had also been completely unroofed.

Where, on the contrary, merely a small hole has been made in the roof, or where only some of the tiles have been removed, direct sunlight will come into operation upon only a small portion of the interior, and the remainder will be illuminated only by diffused light. In such a case no dependence could be placed upon the disinfecting action of direct sunlight, and, as we have said above, there is no evidence to show that diffused light has any influence upon the vitality of the plague bacillus. Thus the question of the utility of knocking holes in the roofs and walls resolves itself into a question as to the utility of these openings for bringing the agency of desiccation effectually into operation. We are of opinion that they are not necessary for this purpose. It is true that, to the extent to which the circulation of air is increased by the making of these openings, desiccation will be accelerated. But inasmuch as there are in practically every house openings which allow of a certain circulation of air, and inasmuch as the floor of practically every native house is raised above the level of the surrounding ground, we think (and this opinion would appear to be borne out by what we have seen of the condition of evacuated houses previous to their being opened up) that the disinfecting agency of desiccation would be effectually brought into operation if, without breaking any holes in the structure, steps were taken to remove from the houses, in addition to the human inhabitants and the cattle, any moist accumulations, such, for instance, as accumulations of manure.

The President does not concur with the opinion expressed in this paragraph.

The President does not concur with the above opinion regarding the value of measures taken to open up houses, and he has expressed his opinion on the matter elsewhere.*

Period required for the disinfection of houses by the agency of desiccation.

673. With regard to the question of what period of time ought to be allowed for the completion of the spontaneous process of disinfection which goes on when materials infected by the plague bacillus are exposed to the influence of desiccation, we may for information on this point have recourse either (*a*) to the experimental data which have been considered above, or (*b*) to such data of actual experience, as bear on the question of the length of time which is required for the dying out of the infection in houses where plague has occurred.

Para. 659 of this Report.

The experimental data are, as we have seen, to the effect that at temperatures of 20° C. or over (these are the temperatures at which all the Indian experiments have been made) the destruction of the plague bacillus by desiccation under the conditions obtaining in the experiments has always been effected within an interval of eight days. The experiments to which we refer, inasmuch as they were instituted in the damp climate of Bombay, and in laboratories rendered more or less steamy by the evaporation of water from the sterilisers and other sources, must be assumed to have been done under conditions which are more favourable to the survival of the plague bacillus than the conditions which obtain in evacuated houses in the drier climate of other parts of India. Thus, judging by the light afforded by the few experiments which have been done, we might, always assuming that the houses are thoroughly cleared out, expect to find all infection extinguished in dry hot weather, by desiccation, in less than eight days. But such an estimate as this is not one upon which much confidence can be placed, for while the period indicated would, no doubt, suffice for the destruction by desiccation of bacilli disposed on the surface of the walls or the woodwork, a much longer period would probably be required for the destruction of plague bacilli incorporated in a moisture-retaining material, such as the cow-dung of the floors. In view of the great importance of the matter, we think that it would be well to institute experiments in order to determine how long the plague bacillus survives when it is incorporated in moist sterilised cow-dung and earth and cow-dung in a cold or damp climate.

When we turn to consider the data of actual experience with a view to determining after what interval of time houses, which have merely been opened up and vacated, may be re-occupied with safety, we find that the experience of the Bombay Presidency, 10. as summed up by Sir Andrew Wingate is to the effect that it seems to be safe to allow infected houses to be re-occupied after they have been vacated for two or three months.

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* *See* Appendix V.

The experience of Lieutenant Bruce was that re-occupation after the houses had been 24,040.
vacated for three months was practically safe. Mr. Giles, from his experience of plague 11,380.
operations in Sind, was of opinion that it was sufficient to keep the people out for two
months. Mr. Moore stated that he did not permit evicted people to return to their
houses "for a month after the last death or recovery from plague"; with respect to 24,450.
the time required for disinfection by the free access of air and light, he went on "the
principle of at least one month; the more the better, but at least one month."

III.(4.)(*j.*) *The Disinfection of Household and Personal Effects and of Grain.*

Measures of disinfection applied to household and personal effects and to grain.

674. The disinfection of household effects, and the disinfection of personal effects, except in so far as this relates to the effects of travellers, is intimately bound up with the question of the disinfection of houses. We have already seen, in connexion with the description of house disinfection which was carried out in the Punjab, how the effects were there dealt with. The methods described do not differ in any important respects from the methods employed in many other places in India, except in the fact that perchloride of mercury was employed more frequently than phenyle. We may, however, note that in certain places it was the practice, in lieu of disinfection by chemical means, to boil clothing; in other places it was the practice to burn all clothing and to break up and destroy in the fire smaller articles of furniture and earthenware vessels and cooking utensils. Where this was done compensation was paid to the owners. In the case of personal effects and clothes carried out into health camps, it was the practice in many places, in lieu of chemical disinfection, to spread out the clothes in the direct rays of the sun. In other cases, again, the disinfection of clothing and personal effects in camp was committed to the agency of the ordinary "light and air."

Para. 706 of this Report.

It is to be noted that, in connexion with the general scheme which was adopted with a view to preventing the spread of plague by railways and over-sea traffic, extensive arrangements were made for the disinfection in steam sterilisers of the personal effects of travellers.

Efficacy of above measures of disinfection.

675. Consideration will show that it is much easier effectively to disinfect clothes by chemical means than it is effectively to disinfect a cow-dung floor by chemical means. For in the case of clothes, even if they be dirty, we have to deal with a relatively much smaller quantity of substances which are capable of decomposing the disinfectant.

Chemical disinfection of clothes.

The question of the efficacy of the various chemical disinfectants which were applied to clothes and other effects is not one which requires to be separately discussed. We have, therefore, here in connexion with chemical disinfection to consider only whether the chemical disinfectants were properly applied. There can be no doubt that the infective material was duly destroyed when the clothes containing it were steeped in the disinfecting solutions, but where, as in some cases, the process of steeping was not resorted to, and where, as we ourselves have seen, the clothes and other objects were merely sprinkled with disinfectant, plague bacilli may easily have escaped destruction.

We have, further, in this connexion to consider the efficacy of the measures of disinfection which have been applied as substitutes for chemical disinfection.

Disinfection of clothes in steam sterilisers.

We may begin by considering the question of the efficacy of the steam-sterilisation of the clothes of passengers and others as it has actually been carried out. We had opportunities for inspecting these disinfecting arrangements at various railway stations, and we are of opinion that owing to the absence of specially constructed steam-sterilisers, and owing to the insufficient training of the staff employed on this work, the disinfecting processes must in many cases be pronounced to have been very ineffective. This criticism, however, applies only to the disinfection of the personal effects of railway travellers. We were able to satisfy ourselves that the arrangements for disinfecting the personal effects of the crews and native passengers shipped at Bombay were quite satisfactory.

Disinfection of clothes by direct sunlight.

The next point which merits consideration relates to the question of the efficacy of exposing clothes to the action of direct sunlight. If we judged by the experimental data which we have considered above, it would appear that the plague bacillus when incorporated in woollen goods, or in thick or closely woven fabrics, is capable of surviving a very prolonged exposure to sunlight. The general impression of experienced officers would, however, appear to be that this measure of disinfection is, in practice, a very effective one. It is quite possible that this was the case, for in addition to the agency of direct sunlight the agency of desiccation was here brought into operation.

Disinfection of clothes by sun and wind in camp.

The next point to consider is the question as to how far the destruction of the infection in clothing is brought about, apart from the direct laying out of these in the sunlight, by their incidental exposure in camp to the influence of sunlight and air. On general principles we might reasonably expect the destruction of the infective material to be brought about by the conditions of camp life which would bring the agency of desiccation into operation. These inferences would appear to be in harmony with the teaching of actual experience, for there is little doubt that where, 9294–7. as for instance in the case of Kankhal and Jawalapur, large quantities of infected personal effects were carried out into camp, these ceased after a time to be infective, although they had not intentionally been subjected to any process of disinfection.

Disinfection of grain by direct sunlight.

Lastly, with regard to the closely related question of the efficacy of the exposure to direct sunlight which was resorted to as a measure of disinfection in the case of the stores of grain contained in the village houses and in the larger grain stores. With regard to this we can base our conclusions only on laboratory experiments. These last would appear to indicate that inasmuch as the sun's rays do not penetrate much below the surface, the exposure of the grain in the open probably operated only in so far as it brought about the completer desiccation of the corn.

Attitude of the people to the measures of disinfection which were applied to their personal effects.

676. Little need be added here to what has been said on the subject of the attitude of the people to the measures of disinfection which were applied to houses. The only further point which it would seem important to note is that clothes and personal effects were often, with a view to avoiding the disinfection, secreted or carried away surreptitiously. 9256, 24,393. As an illustration of the ruses which were resorted to with this object, reference may be made to the fact that in the course of disinfection *en bloc* of the 8780, 9224. town of Kankhal, as many as thirty-nine walled-up rooms were discovered in which clothes and goods had been secreted with a view to preventing their disinfection. In 21,174–5. other places, as in the case referred to by Captain J. B. Smith, I.M.S., the disinfecting coolies were bribed to abstain from steeping the clothes in the disinfecting solution.

III.(4.)(*k.*) *The Disinfection of the Person.*

Disinfection of the person.

677. Disinfection of the person by washing in antiseptic solutions has been carried out in connexion with the plague operations in many places in India. In certain instances it was insisted upon in the case of all travellers from infected areas. At Poona railway station in particular very elaborate arrangements, which were inspected by ourselves, and which have been described in evidence given before us by Major 4027. Bannerman, were made for the disinfection of the person of all travellers. Further, disinfection of the person has frequently been carried out in the case of people who were removed into segregation or health camps, or who were returning to their houses from such camps. In some of these cases arrangements were made for completely douching each person with an antiseptic solution on his arrival in camp. Finally, disinfection of the person of convalescents leaving plague hospitals has in many cases been carried out.

The disinfectants which were employed for this purpose were most frequently either solutions of phenyle or solutions of perchloride of mercury.

Efficacy of disinfection of the person.

678. That the disinfection of the person is effective is indubitable. In proof of this it is only necessary to point to the disinfection of the hands by means of chemical disinfectants which is universal in bacteriological laboratories and in surgical practice. The question as to whether the measure is an expedient measure, as applied to travellers, is discussed below. In the case of persons taken out from plague-infected houses into health camps, and in the case of plague convalescents leaving hospital, we think the measure may have been a useful one.

Attitude of the people towards disinfection of the person. 4298, 21,510.

679. There is no doubt that the disinfection of the person is one of the most unpopular of plague measures, and naturally so, for the measure not only involves a great deal of personal discomfort, but it may also, when the disinfecting solution is a fairly concentrated one, entail a certain amount of severe smarting or subsequent irritation.

III.(4.)(*l.*) *Recommendations with regard to Disinfecting Operations.*

Recommendations with regard to disinfecting operations.

680. In turning now from our survey of the disinfecting operations which have been instituted in India to make certain recommendations as to the future conduct of such operations, we may consider first the question of the agency to be employed in the direction of the disinfecting operations; secondly, the question as to what measures of disinfection ought to be applied; and, thirdly, the question as to what objects ought to be brought within the scope of the disinfecting operations.

(I.) Recommendation regarding agency for

(I.) Firstly, then, as to the agency. We would recommend that the general scientific direction of the disinfecting operations, and the arrangement of technical details, such as the making up of the disinfecting solutions and similar matters, should be committed to a member of the Sanitary Service, the establishment of which is recommended in a subsequent Chapter of this Report. We think, further, that the officer who is actually placed in charge of the disinfection operations should possess at any rate a certain elementary knowledge of the properties of the chemical disinfectants employed, and of the disinfecting agency of heat, desiccation, and sunlight in their application to plague. We think this is of cardinal importance, inasmuch as in our opinion many of the technical errors which have been noticed above as having been committed in the course of disinfecting operations are directly imputable to the fact that these operations were, in most cases, not placed under any scientific direction, but were placed under officers who, being quite new to the work, had to begin almost at the beginning and to find their way by a system of trial and error. The necessity for employing a strong and capable supervising staff wherever chemical disinfection is undertaken will be manifest, in view of the facts which have been placed before us in evidence with regard to the ignorance and negligence of the subordinate disinfection staffs.

carrying out disinfecting operations.

Chap. VII. of this Report.

(II.) Recommendation of chemical disinfection of houses wherever possible.

(II.) In connexion with the disinfection operations, as distinguished from the agency, we may consider first the question of the disinfection of houses.

The actual burning down of houses seems to us a practice which should be resorted to only in the case of temporary structures which are of little or no value, or in the case of houses which are unfit for human habitation.

Kiln-burning and unroofing not recommended.

Owing to the risk of infection from the blowing about of the floor dust, and owing to the fact that it is practically impossible to secure that the whole material shall be carried away, we think that the digging up of the floors with a view to kiln-burning them ought not to be resorted to.

Similarly the complete unroofing of houses, with a view to exposing the interior to the disinfecting agency of sunlight, appears to us to be a needlessly drastic measure for effecting an object which could be brought about by chemical disinfection more expeditiously, without any destruction of property, and with at least as much success. That neither chemical disinfection, nor any of the more drastic measures which involve the unroofing and the prolonged vacation of houses, can be absolutely relied on in every case entirely to extinguish all the infection contained in houses will be clear on a consideration of the instances cited in the section of our Report which deals with the infectivity of houses.

Section VI.(6.)(*a.*) of Chap. III. of this Report.

Chemical disinfection ought, we think, to be resorted to wherever possible. Of all measures of disinfection it is the only one which, when effectively carried out, immediately destroys the infective material present in a room, and renders the room at once practically safe for re-occupation. It must, however, carefully be borne in mind that a disinfected room, though it has been rendered fit for immediate re-occupation, is liable to be re-infected by the agency of rats or men.

The President does not agree with this recommendation.

The President is unable to agree with the opinion implied in this paragraph, that the opening up of houses is unnecessary because its objects could be brought about better by disinfection by chemical substances, and his views are expressed elsewhere.*

(III.) Recommendations regarding parts of houses which should be chemically disinfected.

(III.) We would recommend that the disinfection operations should in towns be restricted to the actual houses in which either plague cases have occurred or dead rats have been found. Where dead rats have not been found, we are of opinion that, in the case of houses containing a number of unconnected families, only the room or rooms which have been occupied by plague patients should be disinfected; while, in the case of houses containing only one family, disinfection should be applied to the whole of the house.

We would recommend that the disinfectant should be applied in ordinary cases only to the floors and to so much of the walls as is in reach of the disinfectors, and to all recesses and places which might have served for the reception of infected clothing. We do not think it is necessary to take any measures with regard to the upper parts of the walls, or to the ceilings, or to the roofs of houses. It is true that in exceptional instances infective material may have been deposited by rats in the roofs—especially in the mud roofs of village houses—but we would urge that the devitalisation of such infective material, deposited as it is in places which are not readily accessible to man, might quite safely be committed to the agency of desiccation, which will, as we have seen, bring about this devitalisation without any assistance on the part of the disinfector. The impossibility of compassing by artificial means the devitalisation of every plague bacillus, and the expediency of committing that devitalisation in all cases where it is safe to do so to the disinfecting agencies of nature, are considerations which ought, we think, to be constantly present in the mind of the disinfector.

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* *See* Appendix V.

(IV.) Use of perchloride of mercury provisionally recommended.

(IV.) The chemical disinfectant which seems to us, under present conditions of knowledge, to be most likely to render efficient service is perchloride of mercury, which may for the purpose of securing complete solution be made up either with hydrochloric acid or with common salt or any other soluble chloride. In view, on the one hand, of the fact that solutions of 1 in 5,000 and 1 in 10,000 are capable of devitalising the plague bacillus, and, on the other hand, of the fact that the plague bacilli, at any rate in a house where the floor has not been freshly re-covered with cowdung, may be expected to lie on the surface of the floor, we think that it will not be necessary to exact that the solution employed shall be sufficiently concentrated to exert a disinfecting action down into the substance of the cow-dung floor as far as the solution penetrates. We think, that in lieu of impregnating the whole floor with a solution of perchloride of mercury in a strength of 1 in 75—the minimum concentration which Dr. Marsh's experiments would seem to indicate as necessary for this purpose—a sufficient margin of safety would probably be provided for if a solution of not less than 1 in 1,000 were employed. The evidence of actual experience in Poona and elsewhere, where an acid solution of this strength was employed, would seem to confirm the inference that a solution of this strength is sufficient.

While provisionally recommending that no change should for the present be made either in the disinfectant, or in the strength of that disinfectant, at present widely adopted for use, we would again insist that the question as to which is the cheapest effective disinfectant and as to what is the minimum strength of that disinfectant which may effectively be employed still awaits resolution. As said before, we think this question could be resolved by experiments conducted on the lines of those instituted by ourselves.

Para. 654 of this Report.

(V.) Method of carrying out the process of chemical disinfection of houses.

(V.) In connexion with the procedure adopted for chemical disinfection, we think the following points ought to be carefully insisted upon :—First, where perchloride of mercury is employed as the disinfecting agent, we think that this disinfectant should be made up by some responsible authority in the form of a concentrated solution in acid. Clear instructions ought to be issued with the disinfectant as to the amount of water to be added. With a view to securing that the dilutions prescribed should be the dilutions in which the disinfectant shall actually be employed, we would insist on the necessity of providing that the capacity of the vessels used for measuring out the perchloride of mercury solution shall be accurately adjusted to that of the wooden buckets in which that solution is diluted for use. We think that the buckets employed should be of such capacity as to hold just the quantity of water sufficient to dilute the measure of concentrated solution to the desired degree.

With regard to the actual means of applying disinfectants, we would suggest that the methods of pumping and throwing them over the walls by means of dippers or other vessels, and of sprinkling them over the household effects with the hands, which methods are at present very widely resorted to, should be abandoned in favour of a system of pouring the disinfectants over the floors and vigorously brushing down the walls with the disinfecting solutions. We make this recommendation in view of the fact that—as shown by certain experiments which we instituted—the disinfectants rapidly run off from smooth, and especially from greasy, walls, without effecting their disinfection.

Before beginning the disinfection of a house or a room, we think, and this is in accordance with the practice which actually obtains, that all the household effects and such furniture as there is should be cleared out and should be placed in the open. When the room itself has been dealt with, the effects ought to be taken in hand. Suggestions as to the procedure to be adopted with regard to these are made below. As soon as their disinfection has been completed, the household effects ought to be replaced, and as soon as the rooms are dry, the inhabitants ought to be allowed to return. It seems to us that, in cases where the disinfection has been carried out with due care, there is nothing to be gained either from a subsequent process of white-washing or from keeping the houses vacated. The appropriate remedy to apply in cases where the disinfection process has been negligently carried out is not to resort to a less effective disinfectant, such as caustic lime, or to a slower disinfective agency such as the agency of desiccation, but to do the chemical disinfection over again.

(VI.) Where chemical disinfection of houses impossible, desiccation should be relied on, houses

(VI.) In cases where it is not possible to carry out chemical disinfection—and cases where it may not be possible to carry out the measure are sure to occur at any rate in villages—the disinfecting agency of desiccation should be relied upon. For this purpose the house ought to be thoroughly cleaned out. The removal from the house of cow-dung and other moist accumulations should be particularly insisted upon, since these will, by giving up moisture to the air, tend to prevent the destruction of the plague bacillus by desiccation.

being vacated ordinarily without structural interference.

We are of opinion that the breaking of holes in the roof or walls and partial untiling will not accelerate the process of desiccation to such a degree as to counterbalance the damage done to the house. While this holds true generally, we think there may be occasions, as for instance when the rains are imminent, when every means of accelerating desiccation may be reasonably adopted.

The President does not concur with above opinion.

The President, for the reasons expressed elsewhere,* is unable to concur with the opinion that " the breaking of holes in the roof or walls and partial untiling will not accelerate the process of desiccation to such a degree as to counterbalance the damage done to the house."

In view of the general tenor of practical experience in the past, and in view of recent observations, which show that under favouring circumstances the plague bacillus, when incorporated in moisture-retaining and close-textured materials, may preserve its vitality for long periods, we think that it would not be an unwise measure to allow, as at present, an interval of at least two months of dry weather to elapse before authorising the re-occupation of the house; in damp and cold climates—and, needless to say, during the rains in India—we think that disinfection by desiccation cannot be relied on.

(VII.) Recommendation that personal and household effects should be broken up and damaged as little as possible in disinfection.

(VII.) We have above, in considering the attitude of the people towards the disinfection of their household effects, referred to their aversion to have their goods and clothes disinfected, and to the endeavours which they make to secrete or convey away clothing and other property. There is reason to believe that infection was in this manner often spread to those who became the depositaries of clothing removed from infected houses. This difficulty makes it a matter of particular importance to consult, so far as possible, the feelings of the people in the carrying out of the disinfection of their personal effects. The difficulty cannot, we think, be met by any system of giving compensation for goods destroyed. It can, however, we think, to a large extent, be met by proscribing all destructive methods of disinfection. In particular, we would recommend that nothing which could by any possibility have any value for its owner should be broken up or destroyed by fire.

(VIII.) Personal and household effects best disinfected by boiling water, or by steeping in a solution of chemical disinfectant.

(VIII.) We have already pointed out that mere momentary immersion in boiling water will, so far as the plague bacillus is concerned, effectually sterilise any infected object. It would, therefore, suffice to boil a cauldron of water, and, while keeping up a brisk fire underneath, to immerse in it the various infected objects. As an alternative to this momentary immersion in boiling water, the infected clothing might, as we saw was the practice in the Punjab and in Poona, be steeped in a solution of a disinfectant. The acid solution of perchloride of mercury, which has been recommended for the disinfection of houses, would, since it would injure the clothing, not be a suitable disinfectant to apply. It would therefore be necessary to make up as was, for instance, done in Poona, in addition to the solution of perchloride of mercury required for the disinfection of the houses, a neutral solution of the same disinfectant for the disinfection of the clothes. All complications such as this are, however, liable to lead to error and confusion unless, perhaps, when all the disinfecting operations are carried out under the immediate supervision of trustworthy Europeans.

(IX.) Recommendations regarding employment of steam sterilisers.

(IX.) We do not think that the procedure of conveying clothes to a distance, to a central steam-steriliser, to undergo sterilisation, is a procedure which is to be recommended. In general we think that steam sterilisers, in view of the fact that they can be relied upon to do their work only when they are placed in the hands of intelligent and perfectly trustworthy persons, are not suitable for general application in India. In most cases the required disinfection can be more simply and equally effectively accomplished by the means recommended above. On the other hand, we recommend that the steam-sterilisation of the effects of native crews and native ship-passengers which is now carried out should be continued.

(X.) Recommendations regarding disinfection by exposure to sunlight and air.

(X.) Where dealing with fabrics which might be injured by immersion in boiling water—we have in view here in particular such articles as valuable silks—these might perhaps be disinfected by exposing them to the direct rays of the sun. In accordance with what we have seen above, a very prolonged exposure—an exposure possibly of several days—would be required to effectually secure the devitalisation of the plague bacillus. During a prolonged exposure, even if the rays of the sun failed to penetrate the fabric, the infective material would inevitably be devitalised by desiccation.

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* *See* Appendix V.

(XI.) Recommendations regarding disinfection of heaps of corn.

(XI.) Lastly, in connexion with the disinfection of village houses and shops, we have to consider the question as to what steps can be taken with respect to stocks of corn which may possibly have become infected by the agency of plague-stricken rats. We think that inasmuch as chemical disinfection is inapplicable, and inasmuch as disinfection by firing is out of the question, the destruction of the plague bacilli which may eventually have been conveyed into these stocks must of necessity be committed to the agency of desiccation. We think that the present method of spreading the corn out in a thin layer in the sun is a very appropriate measure, not so much because it brings into operation the direct devitalising effect of the sunlight, but because it conduces to a more complete desiccation.

(XII.) Recommendations regarding disinfection of the persons of travellers.

(XII.) We think very little indeed is to be gained by the disinfection of th persons of travellers; we therefore recommend that this should be abandoned We base this recommendation on the consideration that it is unreasonable, a the price of the infliction of considerable personal hardship, to attempt the destruction of the infective material which may conceivably be carried about on the persons of travellers when it is quite impossible to provide against the much greater danger of plague being carried about by persons who are in the incubation period of plague, and when it is impracticable, in the case of railway passengers, as will be shown later on, to take any effectual measures to compass the destruction of the infective material which may be carried about in their personal baggage.

(XIII.) Recommendations regarding disinfection of drains, cess-pits, and latrines. Para. 661 of this Report.

(XIII.) We may next consider the question of the practical utility of applying measures of disinfection to drains, cesspits, and latrines. The question, in so far as it relates to drains and cess-pits is, for all practical purposes, resolved by the facts which have been referred to above in connexion with the disinfection of filth by the ordinary processes of nature. The case of latrines is somewhat different, inasmuch as the infective material deposited in these places might possibly spread from person to person before the disinfecting agency which is brought into play by the growth of the saprophytic organisms has had time to effect the devitalisation of the plague bacillus. It will therefore be advisable to continue the disinfection of latrines.

(XIV.) Recommendations regarding disinfection of merchandise. Para. 228 of this Report.

(XIV.) Lastly, we may briefly advert to the question of the disinfection of merchandise.

In this connexion reference may be made to the fact that there was, as we have elsewhere explained, no scientific justification for the statement, circulated in the Press in India, to the effect that the plague bacillus had been discovered, in the bacteriological laboratory at Hyderabad, in cotton which was packed for transport. Further, in connexion with the question of the necessity of applying measures of artificial disinfection to the gunny bags, which form an important article of exportation from India, we found in an experiment already referred to, that the plague bacillus, at the temperatures and under the atmospheric conditions which prevail in Bombay, would appear to be destroyed on gunny bags by desiccation before the expiration of eight days.

Para. 659 of this Report.

We have already said what is essential in connexion with the matter of disinfection of grain in the course of our discussion of the possibility of taking effective measures for the sterilisation of the stores of grain which may be contained in infected houses. What applies to grain applies equally to all other articles of merchandise. It would not, in the case of any variety of merchandise, be practicable to employ any method of disinfection which would bring about the immediate devitalisation of any plague bacilli which might chance to have been introduced into the materials in question. In the case of merchandise the agency of desiccation is the only agency which can be brought into operation. The only possible precaution which could be taken against accidental conveyance of infection by merchandise, would be to insist that merchandise should be received for transport only when it is thoroughly dry. But it will be manifest that security for this is already in large measure afforded by commercial and economic reasons, inasmuch as merchandise would, if shipped damp, inevitably undergo deterioration in transit.

Paras. 227 and 695 of this Report.

In view of the above considerations, we are of opinion that it is neither advisable nor necessary to take any steps towards the disinfection of ordinary merchandise. Rags, as we have seen, cannot be classed with ordinary merchandise, inasmuch as they are very likely to carry infection. Their disinfection in bulk is almost impossible, inasmuch as they are for the most part exported in the form of compressed bales. We have elsewhere expressed our opinion with regard to the exportation of rags.

IV.—MEASURES TO PREVENT THE SPREAD OF PLAGUE.

IV.(1.) *Measures to prevent the Spread of Plague by Sea to Foreign Countries or other Places in India.*

Communication between ports in India and foreign countries.

681. The independent States on the North-Western frontier of India take their own measures to prevent plague from extending from India into the countries that lie north of it, and it appears very unlikely that, even if plague became virulent in Northern India, people would attempt to fly from it in this direction. The only manner in which plague appears likely to be taken from India to any European or distant country is by the sea traffic from Indian ports. These, both in British India and the Native States, are numerous. From the great majority of them vessels run only to other places in India. The ports on the Continent of India, from which passengers and cargo are mainly taken to European ports or to Burma, Ceylon, the Straits Settlements, China, Japan, the Persian Gulf, Africa and Arabia, are Bombay, Calcutta, Madras, and Karachi. There are, however, other places which communicate with Europe, China, and intermediate ports, and there are a number of ports from which small sailing vessels proceed to Burma, the Arabian Coast, the Persian Gulf or Madagascar. Some of them are situated in British India and some in the Native States.

Medical inspection of outward-bound vessels.

682. The medical inspection of outward-bound vessels at the port of Bombay was systematically undertaken in the beginning of February 1897. Rules were then brought into effect to prevent any vessel from leaving the harbour until every one on board had been medically examined, and any person suffering from plague had been removed. A week later similar rules were brought into operation at Karachi; and, in order that there might be no doubt as to the freedom from infection of vessels sailing from Calcutta and Madras, the Governments of Bengal and Madras, with the approval of the Government of India, brought rules of the same purport into force at those ports. Similar regulations were subsequently introduced at many of the smaller ports which communicate with places out of India.

Principles of the Venice Convention.

683. At the Conference held at Venice in March 1897 general principles for regulating the departure of vessels from plague-infected ports were formulated. The following regulations were prescribed by the Convention: firstly, that the medical examination of every person proceeding by the ship should be made on shore immediately before embarkation; secondly, that every contaminated or suspected article should be disinfected on shore in a particular manner; and thirdly, that no person showing symptoms of plague should be allowed to embark.

Examination of passengers on shore at Bombay and Calcutta.

684. The rules in force at Indian ports at the time when the Convention was passed provided that any person showing symptoms of plague should be prevented from departing, but it had been the practice, except in the case of vessels taking Muhammadan pilgrims to the Hedjaz, to conduct the medical examination of crews and passengers on board the ship just before its departure, and considerable difficulty was found in arranging that it should take place in all cases on shore. Consequently, the examination of passengers both at Bombay and Calcutta continued, for a considerable time after the Venice Convention was passed, to be conducted on board ship after embarkation. This procedure was abandoned at Bombay on September 1st, 1898, since which date all crews and passengers on ships leaving Bombay for foreign ports, and many of those on ships leaving for other ports in India, have been examined on shore. At Calcutta the rule requiring crews and passengers to be examined on shore was brought into operation in June 1898 in the case of all vessels leaving for ports out of India, or for the port of Rangoon, or any ports in the Madras Presidency. When Calcutta was declared free from plague in October 1898 the medical examination of crews and passengers was continued, but the regulations then brought into force permitted it to be either on board or on shore as might be most convenient, and, in the case of passengers, certificates from officers of the Indian Medical Service given not more than twelve hours before embarkation were accepted in lieu of the examination by the Port Health Officer. Since Calcutta has again been declared infected, the practice of requiring crews and passengers to be examined on shore has been resumed.

Examination of outward-bound passengers at Karachi.

685. During the earlier period of the outbreak at Karachi, crews and passengers were medically examined, and suspicious persons detained. At a later period, all passengers desirous of leaving by sea were required to obtain a pass, which was only granted when the possibility of a passenger being infected was remote, or when there were urgent business reasons to justify it. In the absence of special circumstances passengers were detained under observation for ten days. They were then sent to the steamers under police escort with passes given to them in the camp. This system, which appears to us to have been unnecessarily rigorous, was subsequently abandoned in favour of medical examination of the same nature as that conducted at Bombay. The rules now in force are that the crews and passengers must be medically examined on shore in the case of vessels sailing for ports out of India. The examination may, in the case of vessels from one Indian port to another, be conducted in the docks or stream, provided that they are not merely touching at Karachi on a voyage to a place out of India.

Karachi is a port from which emigrants are in the habit of leaving for Africa and other places. Emigrants leaving under a contract are subject to the provisions of the Indian Emigration Act, and at present they are prohibited from leaving Karachi. An exception has been made in the case of emigrants going to Uganda, but only on condition that they must have been under observation for ten days previously in a camp where their clothes are disinfected, and be taken straight on board ship from the camp by a police escort. About 7,000 emigrants have been sent under these precautions while plague has prevailed in Karachi. 11,991.

Examination of outward-bound passengers at Madras.

686. Madras, the fourth port from which there is considerable intercourse with Europe, has not yet been infected with plague. But rules for medical inspection at this port and Tuticorin were made in February 1897, and in September 1897 the Madras Government prescribed an examination on shore at these two ports and at seventeen others in the case of vessels sailing to places out of India. An exception to the rule requiring that the examination must be on shore was made in the case of vessels anchored in the Madras roadsteads, and at out-ports the inspection of the officers and crew of a vessel may be conducted on board. Owing to the propinquity of Ceylon, a special regulation was made to prevent any person from embarking on board a vessel bound for Ceylon, who had within the preceding ten days resided in a part of India believed by the Health Officer to be infected with plague. In the case of deck passengers or persons belonging to the labouring classes, a further requirement was made that they should not leave Tuticorin for Ceylon without satisfying the Medical Officer of the Ceylon Government, stationed at Tuticorin, that they had not within the previous ten days resided in an infected part. They were also required to obtain from him a certificate that they had not plague. Vessels belonging to the Ceylon Government leaving with emigrants for Ceylon were exempted from these regulations.

Disinfection of clothing.
740-4.
809-10.
25,486-7.

687. We found on our arrival at Bombay, at the end of November 1898, that the Port Health Officer was not in the habit of treating articles of clothing from an infected area as contaminated or suspicious, unless there was any special reason for so regarding them. It was his practice to decide in each individual case whether an article was to be regarded as contaminated or suspicious or not. It appeared to us that, in view of the possible conveyance of the infection of plague by means of contaminated clothing, it would be better to make it the rule, instead of the exception, to disinfect the clothing of the crews and of the lower classes of native passengers. We accordingly made a recommendation that the effects of crews and native passengers should be disinfected, and the rules now require the disinfection on shore of the clothing and bedding of native crews, third class or deck passengers, and native servants in the case of vessels leaving Bombay, Karachi, or Calcutta for ports out of India.

Work done by the Port Health Officer at Bombay.
25,479-81, App. X. and LXXV.

688. Bombay is the only one of these ports that has been continuously infected since the plague reached India. The evidence of Major Crimmin, V.C., I.M.S., shows the enormous amount of work that has been done by the establishments maintained first under Major MacCartie, I.M.S., C.I.E., and then under himself, as Port Health Officer, in the examination of the crews and passengers of outward-bound vessels. We think that the statistics regarding this work are of sufficient interest to be quoted. Between January 1st, 1897, and March 15th, 1899, 110,851 vessels leaving Bombay on both long and short voyages were inspected, and their crews numbering 980,448, and passengers numbering 962,573, were medically examined. The number of persons examined, whose destination was Aden, the Red Sea, or Europe, was 133,147. Twenty-five thousand and eleven persons were prevented from sailing from Bombay, of

whom 840 desired to go to Aden, the Red Sea, or European ports, 892 to other ports out of India, and 23,279 to ports in India. Two hundred and forty-three of the persons detained are known to have developed plague; but since, at one time, the persons prevented from sailing were not placed under observation, the number that actually developed plague may have been larger.

Method of examination at Bombay 717-741.

689. Major Crimmin has described in his evidence the manner in which the medical examination is conducted. No vessel can leave the harbour without a port clearance, or obtain a port clearance without a bill of health, which is not given until the crew and passengers have been medically examined. The passengers for European and other distant ports are examined at the Ballard pier. The passengers for ports in India are collected for examination in a shed divided into two parts, the larger for the men and the smaller for the women. All women and children are examined by lady doctors.

The method of examination is best described in Major Crimmin's own words. He said:—

"I will divide vessels into two classes, first, those bound for Indian ports, and, 721.
second, those bound for ports out of India. The crews and passengers bound for Indian ports may be examined on board according to the present regulations, but the majority of them are examined on shore. For instance, in the case of the Shepherd Company, who run 35 coasting passenger ships in the week, all the crew and passengers are examined in sheds on shore before they go on board. If a ship is bound for a port out of India, the crew are brought on shore from such vessels for examination in accordance with the Venice Convention. The passengers for such vessels are also examined on shore before they go on board. When there are large numbers of native passengers they are fallen into a line in batches of 100 or 200, according to the size of the examination shed. They open their body clothing, and a Medical Officer feels each man's chest with both hands, which enables him to detect any increase of temperature. The superficial glands in the neck, arm-pits, and groins are then examined. The tongue and eyes are looked at. If he is found to be suffering from a rise of temperature or marked enlargement or tenderness of any of the glands, he is sent to a place set apart for such cases, to undergo a more rigorous examination. His temperature is taken with a Hicks $1\frac{1}{2}$ minute thermometer in the arm-pit, and if he is found suffering from a marked rise of temperature, or enlarged tender glands, he is rejected. The crew are examined in precisely the same way as passengers. * * * If ships are bound for ports out of India the crew are 723.
invariably examined on shore to meet the letter of the Venice Convention. In the case of vessels, which are in dock, and which do not want to go to the inconvenience of bringing their crew on shore after they go into the stream, such crews are examined on shore the day before the vessel sails. We again examine such crews on the day of sailing and as near as possible to the time of departure, after which no loading of cargo or communication with the shore is allowed. We carry out this second examination for two reasons. First, for our own reputation, and to do the best we possibly can to keep plague off ships; and, secondly, to meet the wording of the Official Bill of Health, which states that the vessel, with so many crew, and so many passengers, is at the time of sailing free from plague and certain other infectious diseases. * * *
At the examinations for plague, if we find any person suffering from a marked 725.
rise of temperature they are detained until such time as the temperature goes down to normal, or until we are certain that the fever from which they are suffering is not that due to plague. We go so far as to take out natives with chronic enlargement of the glands of the groin, more especially on ships bound for foreign ports. We do this in the interests of the ship, and very often at the request of the captain. Because 726.
if such a person with enlarged glands was unfortunate enough to be suffering from fever on his arrival at a foreign port from Bombay, it is possible that the Health Officer would class him as a plague case, or return him as a suspicious case."

In the case of vessels such as those of the Messageries Maritimes Company, which make Bombay a port of call, and have no communication with the shore during their stay in the harbour, the examination is confined to the passengers who embark at Bombay.

When the medical examination of passengers has been completed the passengers are, 732.
if the ship is in dock, passed down a gangway on to the ship. The vessel is then moved off the dock wall until such time as the Dockmaster can take her out of dock. If the ship is in the stream the passengers are conveyed direct to her, and she goes to sea at once. In either case, till the vessel has actually left, it remains in charge of a

Customs Officer and one of the European Sanitary Police, and the passengers and crew are prevented from having any communication whatever with the shore.

738. In addition to the medical examination of the crews and passengers steps are taken for the cleansing of the ship. "The vessel itself," said Major Crimmin, "is overhauled and a high sanitary condition insisted on. This includes the painting or lime-washing of crew's quarters; crew's boxes are treated in the same manner. Bilges of native craft are thoroughly washed and cleaned, and the holds of all vessels in ballast are swept clean, as well as disinfected when required, as in the case of coal-ships whose tween decks are often used as latrines by the coolies discharging the cargo. Ships' commanders are in addition advised as to the advantage of the periodical inspection of their crew, and of the frequent exposure of the crew's kit and clothes to the sun and wind. Printed instructions are sent to the shipping agents for issue to commanders of vessels without medical officers, describing the symptoms and the treatment to be adopted should plague break out on their ships."

742. Should a person removed from a ship as suspicious develop plague after the ship has departed, intimation of the fact is sent by telegram to the first port at which it is to touch.

Method of disinfection of baggage.

690. As we have already mentioned, it was not the practice to disinfect the personal baggage of crews and passengers at the time when we first examined Major Crimmin at the beginning of December 1898. The kits of all crews were exposed to the sun, and the baggage of any passenger proceeding to Europe who was known to have had plague was disinfected. There had been only a few instances in which the disinfection of a passenger's luggage had had to be carried out under this rule. When we examined Major Crimmin, the second time, in March 1899, he stated that the practice of disinfecting the clothes, bedding, and boxes of all native crews proceeding to ports out of India, either directly or by way of other Indian ports, had been adopted.

25,487. Major Crimmin thus described his procedure in the matter of disinfection: "The new native crews are collected in the disinfection shed by some official from the shipping office, who brings a copy of the Articles. Native crews from ships in the harbour are brought by one of the officers of the ship. Roll-call from the Articles takes place so as to make certain that we have the total number of native crew, as well as their property. The shed is divided into two portions. In the larger portion the crews' kit is sorted. The crew dress themselves in the cleanest clothing they have, and the remainder of their clothing and bedding is put through an Equifex stove and subjected to saturated steam at a pressure of 10 lbs. to the square inch. This pressure gives a temperature of 239° F., which is said to give absolute disinfection in the case of the most resistant organisms yet isolated. Clothes and bedding are kept in the stove for 15 minutes, and during that time they are subjected to three changes of steam. They are then dried for about five minutes with hot air. Boots and shoes and rain coats are disinfected with a spray of perchloride of mercury of the strength of 1 in 1000, or, if they are greasy, they are sprayed with live steam through a hose from the boiler. The crews' boxes are brushed inside and out, or washed if they are very dirty. They are then rolled about in a large tub containing a solution of perchloride of mercury, 1 in 1000. The kit and boxes are then passed into a second part of the shed, where they are packed, and are then conveyed to the ship under a Police escort. One of the European Sanitary Police goes on board to see that no bedding is stowed away in the forecastle, forepeak, or other parts of the ship. Sometimes they say they have no bedding at all, but we make them find it somehow or other. The floor of the shed is then swept, and the sweepings destroyed in the furnace of the stove."

Since Major Crimmin was last examined the rules as to disinfection of the kits and bedding of native crews have been extended to deck passengers and native servants proceeding to ports out of India. There are very few passengers of this class who embark for Europe, and the linen of all passengers on board a ship which touches at a Continental port is required to be disinfected during the voyage.

Opinion as to manner in which examination and disinfection are carried out.

691. We have had the opportunity of seeing the medical examination of crews and passengers and the disinfection of the kits and bedding of the crews performed by Major Crimmin and his staff. The work is of a very exacting and disagreeable nature, and we found that it was carried out in a most thorough and conscientious manner and so as to completely satisfy the letter and spirit of the Venice Convention. We were not able to make as close an inspection of the arrangements at Calcutta (which had not been declared an infected port at the time of our visit there) or Karachi, but we have no reason to believe that the medical inspection is not carried out at these ports with the same care and exactness as at Bombay, and in accordance with the rules which now strictly conform to the Venice Convention.

Regulations enforced at Aden.

692. It is necessary, in connexion with the measures taken in India to protect other countries, to refer to the regulations enforced at Aden, the port of call between India on the one side, and the Red Sea and Europe on the other. In October 1896 quarantine was imposed at Aden against Bombay. The regulations prescribed 15 days' quarantine in the case of vessels on which plague occurred, and eight days' quarantine in the case of vessels on which no case had occurred, but which did not carry a qualified Medical Officer. They allowed immediate free communication to a vessel on which no case of plague had occurred and which carried a duly qualified Medical Officer. The Port Health Officer was required to make a medical inspection of a vessel before granting free pratique. In December 1896 the quarantine regulations at Aden were applied to Karachi as well as Bombay.

Under the terms of the Venice Convention of 1897, a healthy ship is defined to be any ship, even though coming from an infected port, which has had no death or case of plague on board, either before departure, during the voyage, or on arrival. A healthy vessel is entitled to free pratique, but the authorities at the port of arrival can impose restrictions if they think fit, the maximum of such restrictions being those laid down by the Venice Convention. Consequently, the rules now in force at Aden admit immediate free pratique to all healthy vessels, even though they may have less than a ten days' passage from an infected port. They provide that the crew and passengers on healthy vessels, which have left an infected port less than ten days before arriving at Aden, shall be medically inspected; that the soiled linen and personal effects of the crew and passengers which appear contaminated shall be disinfected; that a watch shall be kept over the health of the crew and passengers for ten days from the date of the arrival of the ship; and that the crew shall not be permitted to land except on duty. Vessels using Aden merely as a port of call have the option of remaining in quarantine instead of seeking free pratique, and this course is found to be the more convenient to them since the medical examination, which is the condition of their receiving free pratique, results in delay. Any cases of plague discovered on board ship are removed in the ship's own boats to Alia Island. The number of cases landed at Aden since plague began in Bombay has been very few, and in no case has any person at Aden become infected owing to the landing of a plague-stricken person.

Smallness of number of plague cases that have passed through testifies to efficiency of control over vessels leaving India.

693. The arrangements made for the control of vessels leaving ports of India for ports in Europe seem to us to have been, on the whole, most successful. The evidence given to us has shown that since the outbreak began in India in 1896, very few vessels have carried away the infection of plague, and that the cases of plague on board ship discovered at Suez, or west of it, have been very few. The only cases which have come to our notice officially are those of the two Goanese stewards who contracted plague on arrival in London, apparently after using clothes which had been closed up in a box since the time of departure from Bombay, the case on the troopship *Dilwara*, in March 1897 (which occurred before the troops, women, and children going by troopships were subject to examination by the Port Health Officer), that of the fireman on the Peninsular and Oriental Company's s.s. *Carthage* in July 1898, and that on board the British India Steam Navigation Company's *Golconda*. In the latter case (which occurred in December 1898), the symptoms shown by a passenger after leaving Marseilles raised a suspicion that he was suffering from an attack of pestis minor. It was not known that he had before leaving Calcutta been in communication with any one suffering from plague. Beyond the fact that the man had enlarged glands, there was nothing to show that he had plague. It has come unofficially to our notice that two cases of plague were discovered at Suez on the steamer *Dictator*, which, having left Bombay for Liverpool *viâ* Karachi and Perim on June 14th, arrived at Suez on July 9th, 1899.

Local Government Board Report for 1896-7, pp. 129-133. 755-6. 799-803. 27,415.

Apart from the cases discovered at Suez, or west of that port, a certain number of cases have been detected on ships while in Eastern waters on their way from India to Europe or the Red Sea. There were two cases on the *Pekin* a pilgrim vessel, 752-4. in 1896, one on the *Carthage* before reaching Aden on the same voyage on which 757. the case already referred to occurred, one on the Peninsular and Oriental Company's s.s. *Shannon* in 1898 while taking the mails from Bombay to and from Aden, 759-60. one on the Peninsular and Oriental Company's s.s. *Clyde* in April 1898 while 761. employed on the same duty, a case on the Peninsular and Oriental Company's s.s. *Bengal* 763. in August 1898,—which, though detected on board, was contracted four days after the ship returned to Bombay, and, therefore, may be left out of account,—one case each on 765. the Peninsular and Oriental Company's s.s. *Ballarat* and *Bengal* in August and October 1898 respectively between Bombay and Colombo, and five cases on the *Patna* (British Indian Steam Navigation Company) in March 1898 while on a 763; 12,243-4. voyage from Bombay to the Persian Gulf. During the recent recrudescence of plague in Bombay the only cases reported up to the time of our leaving India were the two

cases alleged to have been detected at Suez on the Peninsular and Oriental Company's
25,489-90. s.s. *Caledonia* in November 1898, a case on board the British Indian Steam
25,491. Navigation Company's *Buldana* between Bombay and Rangoon, and the seven
12,250; 25,495-7, cases on the British Indian Steam Navigation Company's *Bhundara* during her voyage from Karachi taking emigrants to Uganda in December 1898. We think it is clear from the reports of the Medical Officer at Suez that one of the cases on the *Caledonia* was not plague, and it seems to us very doubtful whether the second one was. The occurrence of the cases on board the *Buldana* does not seem to us to have been due to any defect in the medical examination of the crew at Bombay, and no member of the crew was attacked. But as the clothing of the crew was not disinfected at Bombay, and as some of the emigrants may possibly have become infected by escaping for a time from the Kiamari detention camp at Karachi, the infection of the ship may have been due to either of these causes. A case of which we have indirect information is that of the *Annie Maude*. In July 1897 this ship was
26,934. placed in quarantine by the United States Quarantine authorities, on the ground that one of the crew died shortly after the vessel left Calcutta, and two more of the crew suffered with buboes from which they recovered.

In view of the enormous amount of outward-bound traffic from India, the discovery of this small number of cases of plague on vessels bound for European and other ports testifies, we consider, to the thorough and efficient manner in which the medical examination of crews and passengers at the more important Indian ports has been conducted.

25,494. As it had been alleged in the public Press that the plague reached Tamatave, in Madagascar, from Bombay, we examined Major Crimmin as to the possibility of the infection having been taken in this manner. No vessel had left Bombay for Madagascar since August 1897, and it is clear that the origin of the infection at Tamatave in the autumn of 1898 must be sought for elsewhere. It is possible, though there is
13,347; 13,513-5. no direct evidence on this point, that it may have been taken by one of the sailing vessels that ply between Cutch Mandvi and Madagascar.

Little danger from rats on ships, and disinfection of holds impracticable.

694. On the *Shannon* and *Patna* dead rats were found when cases of plague occurred on those ships. It is quite possible that the rats on these ships were infected by the same cause as the human beings. There is, therefore, no proof that on board ship men have become infected from rats. On the other hand, no mortality of rats was observed on 13 ships on which plague occurred among human beings. As far as we know great mortality among rats has not been observed on ships that have left Bombay, and it has
17,677. certainly not been observed on ships in Bombay harbour. Although, theoretically, it is possible that plague-infected rats might carry the disease from one country to another, there is absolutely no evidence that infection has ever been carried in this manner. We think that the suggested fumigation of the holds of ships so as to destroy the rats is both unnecessary and impracticable. The fumigation would have to be done before the cargo is put in the hold, since it would be impossible to fumigate the hold afterwards.

Practical extent of danger of spread of plague by sea, and measures necessary to guard against it. Paras. 227-9, 262, and 659 of this Report. Centralblatt für Bacteriologie, 20th December 1899.

695. The question of the infectivity of articles of merchandise has been discussed elsewhere, and it will suffice here to note that articles of merchandise are not, in our opinion, often likely to be the means by which plague is conveyed from one port to another. The reports in the public press as to the manner in which Oporto has become infected with plague, are, we are aware, to the effect that the infection was brought in the cargo of a ship from Bombay. We find, however, that Dr. Kossel, one of the German delegates who proceeded to Oporto to study the outbreak there, reported that there was no direct communication between Oporto and any plague-infected places, and that the *City of Cork*, the ship which was at first suspected of having introduced plague, traded regularly between Oporto and London only. The manner in which plague was introduced into Oporto has remained undetermined. In comparison with the danger of the importation of plague infection from India into Europe by means of germs of the disease carried either by human beings, or by clothing, baggage, and rags, the danger of the importation by means of germs
Para. 197 of this Report. carried by articles of ordinary merchandise seems to us to be insignificant. We have already expressed our opinion that the period of incubation is, as a rule, much shorter than ten days. Although it is a defect of any system of medical inspection that it can result in the detention of a member of a crew or of a passenger only if he has either got plague upon him or has been attacked by the febrile symptoms which herald its approach, it is extremely improbable that a person who is infected when he embarks on a ship would not develop plague very soon after the commencement of a voyage. The occurrence of any of the symptoms of plague on board a ship should lead to the immediate discovery of the case, and if every suspicious case is at once isolated and treated as a case of plague, there is little or no

danger of its spreading. Experience in hospitals confirms that gained on board ship. viz., that the spread of plague can be immediately checked if ordinary precautions for proper ventilation, disinfection, and sanitation are taken at once. The danger then that plague will be taken into Europe by persons who have developed plague during their voyage from India is, we think, extremely small—so small, indeed, that it may safely be ignored. There is, however, it appears to us, a possibility of infection being carried to Europe by means of contaminated clothing; and for this reason we attach the greatest importance to the system for disinfecting the clothing and bedding of the crews and lower classes of passengers that has lately been introduced. So long as plague remains widely diffused over India, we think that it is desirable to enforce at all ports in India from which ships sail to ports out of India—and in the category of ports out of India we would include the ports of Burma—the same rules as to medical examination and disinfection that are at present in force in Calcutta, Bombay, and Karachi. No measure short of this can give security that a passenger may not embark with infected clothing at an uninfected port. It is also, we think, most essential that vessels of any kind leaving ports such as Cutch Mandvi for Madagascar, Zanzibar, Arabia, and the Persian Gulf, and other places out of India, should do so only after full precautions have been taken to prevent them from carrying the infection.

Prohibition of export of rags a wise precaution.

With regard to merchandise, we have elsewhere seen that rags constitute the only kind of merchandise which is likely to spread plague. We have also seen that it is impossible effectually to disinfect rags when compressed in bales for exportation. We, therefore, think it is a wise precaution to prohibit the exportation of rags from an infected district.

Arrangements connected with pilgrim traffic to Hedjaz. 12,265–8.

696. In addition to the ordinary traffic of passengers and merchandise from India, there is the traffic of Muhammadan pilgrims to the sacred places in the Hedjaz. From inquiries made in Bombay and Karachi, we ascertained that pilgrims for the Hedjaz from India go entirely by sea, and that no large caravans start, as has been sometimes stated, from the Persian Gulf. The traffic by sea has for a long time been regulated by special rules designed to prevent the introduction of epidemic disease from the East into Europe. Those now in force are based on the Convention of Paris of 1894, the conditions of which are embodied in Chapter I. of the Venice Convention, and in the Indian Pilgrims Ships Act (No. XIV. of 1895), and the rules issued by the authorities in India under the powers conferred by that Act. The Act requires that the pilgrims shall invariably, whatever may be the state of health at the port from which the vessel sails, be medically inspected on shore before they are allowed to embark, and that all articles suspected of being contaminated by persons suffering from cholera or any dangerously infectious or contagious disease shall be disinfected. Under ordinary circumstances nearly all the pilgrims from India, including those who have come from Central Asia, take their departure from the port of Bombay, and in accordance with these rules, two vessels left Bombay for Jedda in December 1896 and January 1897 respectively. Sixty pilgrims also sailed from Calcutta, which was then a healthy port, in the same month. It has already been mentioned that two cases of plague occurred between Bombay and Aden among the passengers by one of these steamers (the *Pekin*), 752–4. but the vessel was not further infected. Steps were taken to prohibit, with effect, from February 1st, 1897, the departure of pilgrim ships from either Bombay or Karachi, and every effort made to dissuade Muhammadan pilgrims from proceeding to the Hedjaz. Subsequently, on February 16th, 1897, a regulation was issued under the Epidemic Diseases Act, prohibiting all persons residing in the Bombay Presidency or Sind (the only two parts of India which were then infected with plague), or who had entered the Bombay Presidency or Sind with the object of going on the pilgrimage, from embarking at any port for the Hedjaz, and special arrangements were devised for subjecting to the strictest observation any residents of uninfected areas who might persist in their wish to go on the pilgrimage. But before these arrangements could be brought into operation, the apprehensions felt by all the European Governments, including Turkey, that the plague might be communicated to Europe led Her Majesty's Government to decide that the pilgrimage must be completely suspended for the time being. The Indian Government accordingly directed, on February 20th, that the pilgrimage should be suspended, and no more pilgrims were permitted to leave India for the pilgrimage of 1897. The port of Bombay has been continuously infected since that date, and no pilgrims have been allowed to leave it for the Hedjaz. But the Government of India, with the sanction of the Secretary of State for India, determined, when the time for the pilgrimage of 1898 was approaching, that it was desirable to withdraw the absolute prohibition against the departure of pilgrims from India, and to permit those resident in uninfected areas to depart under the most stringent precautions from ports which remained free from plague. The ports from which it was determined to permit pilgrims to depart were Karachi and Chittagong. By a notification under the

Epidemic Diseases Act issued on 20th November 1897, the Government of India prohibited the embarkation of any pilgrim to Mecca from the Bombay Presidency and Southern India. All other persons resident in other parts of India were required to go into a camp of observation for ten days before they were permitted to embark, under the usual precautions as to medical inspection and disinfection, at either Karachi or Chittagong. While withdrawing the prohibition against the departure of healthy pilgrims from uninfected ports, the Indian Government made every endeavour, through the influence of their officers and of the religious heads of the Muhammadan community, to dissuade intending pilgrims from going to the Hedjaz. As the result of these measures, the only vessels which took pilgrims from India to the Hedjaz in 1898, were one which sailed from Karachi with 200 passengers, and another from Chittagong with 708 passengers. The port of Karachi was re-infected in the spring of 1898. It has remained so ever since, and no more pilgrims have sailed from it. In November 1898, the Government of India determined to continue, with regard to the pilgrimage in 1899, the prohibition against the departure of pilgrims resident in infected areas, and to permit residents of uninfected areas to sail only from the port of Chittagong, and only after stringent precautions as to observation, medical inspection, and the disinfection on shore of every article taken on board by the pilgrims. Two vessels have sailed from Chittagong in accordance with these regulations, one in January 1899 with about 740 pilgrims, and one in February 1899 with about 530 pilgrims.

In addition to the stringent precautions taken before the pilgrims for the Hedjaz sail from India, the Turkish authorities impose quarantine for 15 days on the pilgrim vessels after their arrival from India at the quarantine station at Camaran.

Under existing arrangements little fear of importation of plague to Europe from India *viâ* Hedjaz.

697. The Venice Convention does not prohibit the departure of pilgrims even from a plague-infected port, so that the precautions which have been taken in India to prevent pilgrims who are resident in infected areas from going on the pilgrimage, and to permit pilgrim vessels to sail only from uninfected ports and under the strictest precautions, go beyond what is required by the Convention. They appear to us, however, to be well devised. So long as they are maintained it need not, we think, be apprehended that the plague will be imported into Europe by means of the pilgrimage of Muhammadans from India to the Hedjaz. No case of plague has been taken from India to Mecca since the outbreak began in India. Mecca is, in our opinion, far more likely to be infected by plague from the indigenous foci in its neighbourhood at Assyr, than by the infection being brought from India; and indeed it is probably from Assyr that the plague, which has appeared in Mecca in the last three years, has been derived.

IV.(2.) *Measures taken at the Place of Arrival of ships from Infected Ports.*

Quarantine.

698. The British and Indian Governments are opposed to the imposition of quarantine, but, owing to the anticipation that foreign countries might impose quarantine against non-infected Indian ports unless quarantine against vessels arriving from Bombay was imposed at them, quarantine against Bombay was, in October 1896, imposed at Calcutta, Madras, Karachi, and Rangoon. The regulations enforced at Karachi were similar to those already referred to as having been imposed at Aden. The rules at the other three ports were less strict, in that if satisfied that there had not been a case of plague on board the vessel, the Port Health Officer was authorised to give free pratique, whether the vessel carried a qualified Medical Officer or not.

The quarantine regulations at the ports of Calcutta, Rangoon, and Madras were extended to Karachi in December 1896. The regulations against Bombay, at the latter port, were at the same time relaxed so as to allow free pratique to be granted at once to a vessel on board of which no case of plague had occurred, provided that it carried a Medical Officer. Eight days' quarantine was imposed in the case of a vessel with no Medical Officer, even though no case of plague had taken place on it. When a case had occurred on any vessel the sick and their attendants were landed and segregated, while the other passengers were allowed to land under precautions such as the Port Health Officer considered necessary, and the vessel was disinfected.

Subsequently, as the epidemic of plague increased in the Bombay Presidency, the quarantine regulations were extended to a number of the minor ports on the South. West, and East Coasts of India, with a view to their own protection.

Measures other than quarantine.

699. The changes made by the Venice Convention of 1897 in the treatment of ships arriving from ports infected with plague rendered it unnecessary to maintain quarantine, and regulations, based upon the principles laid down in the Convention, have since been prescribed for observance in the case of vessels arriving at other ports in India from infected places on the seaboard.

Although Bombay has remained continuously infected since plague was discovered there in 1896, there have been times when the infection at other ports was more serious than the infection at Bombay. It was feared that people returning to Bombay from infected places at the time when plague was declining in Bombay might cause a re-infection of the city. The inspection of incoming vessels from infected ports was, 768.
therefore, undertaken at Bombay in April 1897. Up to 30th April 1898, all people coming from ports between Karachi, on the north, and Bhatkal, on the south, of Bombay, were examined. Since that date the inspection has been limited to those coming from infected ports.

The regulations of April 1897 required all native vessels arriving at Bombay to bring up at one of three anchorages. Of passengers from ports other than Cutch Mandvi, and those situated in the district of Kolaba (which two places were then very seriously infected), only those whose temperature was above normal were detained, and they were discharged from 24 to 48 hours afterwards, if the temperature fell to normal in the meanwhile. Passengers from the Kolaba district were detained five days, and those from Cutch Mandvi eight days. At a later stage the system of surveillance by medical inspection of new-comers in their houses was tried, but had to be abandoned for two reasons. Great difficulty was experienced in finding the house to which the newcomer had gone, and the inspecting officer found it impossible to satisfy himself that the people he examined in the house were the people who had passed out of the camp under surveillance. It was, therefore, found necessary to 772.
bring people under surveillance to the observation camp for examination, and an attempt was made to prevent the danger of personation by photographing groups of persons admitted to surveillance.

Regulations at present in force at Bombay.

700. The rules in force in Bombay, though they apply to a port not itself free from plague, may be taken to illustrate the practice in force at ports which are not infected. A ship from a non-infected port, or a port which is supposed to be non-infected, is on arrival at Bombay boarded by the pilot, who inquires whether there are 781-93.
any cases of certain specified diseases on board, or whether there have been such cases during the voyage. It is only when there have been cases of such diseases, or suspicious deaths during the voyage, that the doctor's flag is hoisted, and then the ship has to remain in quarantine until she has been visited by the Health Officer and has received free pratique. Every vessel, including native craft, which arrives from an infected port, or has been in communication otherwise than orally or by signal with a vessel from an infected port, or has plague on board, or has had a case of plague on board within 12 days before arrival, is required before entering the harbour by day to hoist a yellow flag, or to show the quarantine signal by night, until permitted by the Health Officer to remove it. Vessels are required to anchor at specified places, and are allowed to take the pilot, police, or customs officer on board, but are not permitted to hold any communication, except orally, with the shore or with any other vessel or boat until pratique has been granted. The Health Officer then inspects the ship, and classes it as "infected," "suspected," "ordinary healthy," or "healthy," as the case may be. The definitions of "*infected*" and "*suspected*" vessels are those contained in the Venice Convention. An "*ordinary healthy*" vessel is a vessel, not being an "infected" or "suspected" vessel, which has within the period of 10 days preceding her arrival left an infected port or communicated otherwise than by signal or orally with a vessel which has left an infected port within that period. A "*healthy*" vessel is a vessel which is not "infected" or "suspected," and has left an infected port more than 10 days before arrival, has not had a death on board from unknown or suspicious causes, and has not within the period of 10 days communicated, except orally or by signal, with a vessel from an infected port. In the case of "healthy" vessels it is in the discretion of the Health Officer to medically examine the passengers and crew, and to disinfect any of the soiled linen and personal effects of the passengers and crew which he may consider infected. In the case of "ordinary healthy" or "suspected" vessels, these two measures must be undertaken, and the passengers and members of the crew who are, in the opinion of the Health Officer, likely to spread infection are sent to the appointed place and kept under observation. The remainder of the crew stays on board under the observation of the Health Officer, and the rest of the passengers have to comply with all directions as to medical inspection or otherwise that may be given to them in written orders. In the case of "suspected" ships, all parts of the vessel which have been occupied or frequented by plague patients must be disinfected, and all other parts of it may be disinfected at the discretion of the Health Officer. In the case of an "infected" vessel, in addition to these precautions, the sick are disembarked

and sent to the camp or hospital. The persons under observation are detained for such period, not exceeding 10 days, as may be determined on, having regard to the sanitary condition of the vessel and the manner in which it has been classed. In the case of an "ordinary healthy" vessel the detention terminates on the eleventh day from the departure of the vessel from an infected port, or the date of her communicating with a vessel from an infected port, whichever is more recent. In the event of a case of plague occurring among the persons under observation, the patient is sent to hospital and a fresh period of 10 days' detention of the other persons in the camp commences from the time when the patient suffering from plague has been removed. The Medical Officer in charge of the camp may permit a person under observation to proceed to his home on condition of his complying with directions as to medical inspection and other matters given to him in the form of a written order. There are difficulties in India which do not occur in Europe in the matter of allowing persons to proceed, under surveillance, to their homes. In the large ports many people are unable to give an accurate, or even approximately accurate, address, and there is always a danger of personation, of the duty of reporting being ignored, and of a person changing his residence. Many of the difficulties in the matter of surveillance can be, and have been, removed by the use of photography, and by getting the leaders of the different communities to become responsible that the members of their body allowed to go to their homes shall appear at the prescribed time for medical inspection; but there will always, it is feared, be a considerable residuum whose addresses cannot be properly determined, and who cannot be relied on to fulfil their obligations as to coming to be medically inspected, and it will be necessary to keep these under close observation for the prescribed period.

Statistics of examination of ships arriving at Bombay and Karachi.

701. The examination of passengers on inward-bound vessels from infected ports has
imposed very onerous duties on the Health Officers at Bombay and Karachi. From
January 1st, 1897, to March 15th, 1899, 51,213 vessels, with crews numbering 404,934,
and passengers numbering 520,699, were examined at Bombay. Of those examined up
25,479. to the beginning of December 1898, 873,197 in number, 43,477 were segregated for
771-2. periods varying from two to ten days. Forty-eight of those segregated developed
12,145-6. plague. At Karachi between August 1st, 1897, and December 1st, 1898, crews and
passengers from infected ports, numbering 69,366, were examined at Karachi. Only
one person was found to be suffering from plague at the time of inspection.
12,160. The number of passengers detained in the camp was 35,360. The large number
12,151. of passengers detained is accounted for by the fact that between the termination
of the epidemic of 1897 and the beginning of that of 1898, all passengers
12,162. were detained for 10 days. Among the passengers detained, five cases of plague
occurred, and one man belonging to a crew who was sent ashore as a suspicious case,
developed plague.

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Conclusions regarding examination of vessels arriving from infected ports.

702. The number of cases of plague which developed at Bombay and Karachi among people arriving from infected ports was very small. The results do not, we think, compensate for the labour and expense involved in examining passengers who arrive at an infected port from another infected port. If, however, it be considered necessary to maintain this form of examination, we think that in the case of a "healthy" or "suspected" ship, coming from one infected country into another, free pratique should, provided no case of sickness has occurred on board, be given at once without any further formalities. It also appears to us undesirable to make a distinction between an "*ordinary healthy*" and a "*healthy*" ship, which is not contemplated by the Venice Convention. Lastly, in the case of an "infected" ship coming into any port, all that appears necessary is to provide that, if possible, the sick shall be landed and isolated, and the personal luggage of crews and passengers and the ship disinfected. The other passengers should be allowed to land, and should be kept under observation at their own homes for a period not exceeding 10 days after leaving the ship. Only those who cannot be kept under observation in this manner need be placed under detention in a camp.

IV.(3.) *Measures to prevent the Spread of Plague from one part of India to another by Railway.*

Summary of measures adopted on railways in India.

703. In connexion with the possibility that plague might be spread by travellers on the railways, it had to be considered whether any restriction should be placed on railway travelling from an infected area. The idea of prohibiting such travelling

altogether could not be entertained; but it was decided that an attempt might, and ought to, be made—

First, to prevent the departure from the plague-stricken locality of anyone showing symptoms of plague:

Secondly, to detect and remove from the train anyone who, though he might not have shown signs of plague at the time of departure, had developed them in the course of his journey:

Thirdly, to keep under observation, for some days after their arrival at their destinations, passengers from infected areas who might be in the incubation stage of plague, though they had not shown any symptoms of the disease up to the time of their arrival:

Fourthly, to prevent passengers from carrying the infection in their dirty clothing or bedding.

With this object arrangements were made, early in October 1896, by the civil and railway authorities working in co-operation under sections 47 and 71 of the Indian Railways Act (IX. of 1890), for the medical examination of outward-bound passengers at each of the railway stations in Bombay City. The following precautions were also adopted at about the same time throughout India generally:—

(1.) A system of medical examinations was instituted at intervals along the railway routes which led outwards from the infected area:

(2.) A system of surveillance was adopted by which arrivals from infected areas were kept under observation for the period of incubation either at their homes, or in special camps, according as they could or could not be depended upon to report the occurrence of plague, or to give a correct name and address at the place of arrival:

(3.) Arrangements were made to disinfect so much of the clothing and effects of travellers from plague-stricken places as seemed likely to be contaminated with plague.

These are the precautions which have from an early stage in the outbreak been regularly adopted throughout India generally. There are, however, two others which were subsequently to some extent resorted to, but only at certain places, and for a limited time. One was—

(4.) A system of detention camps established with a view of detaining, for the period of incubation, travellers from infected areas, whether suspicious or not.

The other was—

(5.) The stoppage of all booking of passengers from an infected place generally, or the stoppage of booking from an infected place to a particular place which it was feared would become infected.

We may deal with each of these five measures separately.

(1.) The medical examination of travellers at intervals along the railway routes which lead outwards from the foci of infection.

704. The medical examination at the different stations in Bombay City was calculated to prevent such persons as were actually suffering from plague from leaving the infected area. But it was necessary also to endeavour to prevent persons who might before the beginning of their journey have contracted plague, but who had not up to that time shown symptoms of it, from carrying it about the country after it had been developed. With this object arrangements were made at the beginning of October 1896, for the medical examination of passengers from Bombay at a number of selected railway stations in different Provinces. And as plague increased in Bombay these arrangements were made more stringent. The law, however, as it then stood, did not give sufficient power to the authorities; and it was not till the Epidemic Diseases Act was passed, in the beginning of February 1897, that the arrangements were extended and thoroughly systematized, and the whole scheme of medical examination of passengers by railway was brought into proper order.

At that time the chief centres of infection were the cities of Bombay and Karachi. Nine lines of railway lead from the direction of the former, and two from the direction of the latter place, in most cases joining with the lines from the other Provinces of India. The arrangements made on the passing of the Epidemic Diseases Act are very clearly and fully explained in Chapter X. of Mr. Nathan's book on the plague in India, and it is not necessary to reproduce the details of them here. They involved the medical examination of passengers at certain principal railway stations selected as suitable for the supervision of through traffic, and also that of passengers alighting at important centres of population. All persons found at the inspection to be suspicious were detained. In addition to the arrangements at

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the main places for medical inspection, the local governments instituted examinations by native medical assistants at subsidiary stations on the main and branch lines. The inspection stations became very numerous, and the staff employed on them very large. Special arrangements were made that the examination of female passengers should be conducted, as far as possible, by female medical practitioners and nurses.

An idea of the extent to which endeavours were made to medically examine through travellers may be gathered by referring to the arrangements made for the examination of passengers on the journey from Bombay to Calcutta. The first principal examination was at Kalyan Junction, 34 miles from Bombay; the second at Manmar Junction, near the borders of the Hyderabad State, 128 miles from Kalyan; the third at Bhusawal near the borders of the Bombay Presidency the Central Provinces and the Hyderabad Assigned Districts, 114 miles from Manmar; the fourth at Itarsi Junction in the Central Provinces, 188 miles from Bhusawal; the fifth at Manikpur Junction in the North-Western Provinces, 316 miles from Itarsi; and the last at Chausa, 199 miles from Manikpur, and just within the borders of the Province of Bengal. A passenger from Bombay to Calcutta would thus have to be examined six times during his journey, and like precautions were taken in the case of passengers by all other routes.

(2.) The system placing arrivals from infected areas under surveillance in their homes for the period of incubation.

Para. 707 of this Report.

Section II.(1.)(*b.*) of this Chapter.

705. The importance of keeping a watch for the maximum period of incubation on the health of persons arriving from the infected area was recognised in all Provinces at an early stage of the outbreak in Bombay; and by March 1897 rules with this object had been very generally issued. Subsequently, after the plan of detention in quarantine camps (to be presently alluded to) had been tried and abandoned, the system of surveillance was still more extensively employed. We refer to it elsewhere, and need not therefore say more on the subject here.

(3.) The disinfection of suspicious clothing and baggage of travellers.

Para. 674 of this Report.

706. The measures which have been described above were, in many cases, re-inforced by measures which were taken to disinfect the luggage and persons of travellers. Arrangements were made for the disinfection of the clothing and effects of each person removed from the train and detained, and, at stations on the frontiers of the Bombay Presidency, the disinfection of the clothing and effects of all third-class passengers from infected areas was arranged for. It was at one time the practice to disinfect the persons of all those detained in the camps, but this has been generally abandoned. These measures have been dealt with under the heading of disinfection; they need not, therefore, be specially described here.

We pass now to the exceptional and temporary measures—detention and stoppage of booking—that were resorted to in particular parts of the country and at particular times.

(4.) Detention camps on or near railway routes for detention of passengers from infected areas.

1285.

14,106-57.

14,165-93.

707. When the second epidemic of plague was raging in Bombay City, and when the plague was widespread in the other parts of the Presidency, the Bombay Government considered it impossible to arrange for medical examination so thorough as to check the spread of plague. In order more effectually to check the travelling of persons with plague in them, they instituted a system of detention camps, at which passengers were detained for a fixed period, and all third-class passengers were disinfected. These detention camps were stopped just before the commencement of the rainy season of 1898, and in October 1898 it was determined not to re-open them for the fair season. A description of the detention camp at Anand, on the Bombay, Baroda, and Central India Railway, is given by the officers who were employed on it. It was opened on the 24th November 1897, and closed as a detention camp in May 1898. The period of detention varied from time to time, the maximum being ten days. Every one from an infected locality was detained with the following exceptions:—

(*a.*) Europeans;
(*b.*) Government servants, or servants of a Native State travelling on duty;
(*c.*) Railway servants travelling on duty;
(*d.*) Persons holding certificates showing that they came direct from an authorised camp of detention where they had been under observation for at least a period of 10 days;
(*e.*) Persons holding such passes as were from time to time notified by the Plague Commissioner as conferring exemption from detention;
(*f.*) Persons giving satisfactory proof that they had come from uninfected localities of which they were residents.

Practically the whole train was emptied out, and all the passengers detained, and examined medically twice a day during the period of detention, the persons who came within the exceptions mentioned being very few. This system was a form of quarantine modified only to exempt certain classes as such, and not entirely because they were less likely to carry plague than some of the passengers who were detained.

Besides the Government detention camps at certain points on the railway for all down passengers found in the trains there, whether through passengers or alighting passengers, the Municipalities at most of the chief towns in the Bombay Presidency lying on or near the railway maintained detention camps of their own, in which persons from infected areas on alighting from trains were detained for ten days before being allowed to go to their houses.

When in October 1898 the Bombay Government determined not to re-open their own detention camps, they decided that those also maintained by the Municipalities should be abandoned. In place of detention camps they determined to substitute throughout the Presidency an arrangement for the medical examination of each traveller, and the disinfection of suspicious articles. 1285.

Detention camps similar to those in the Bombay Presidency were adopted also at a few places outside its limits. In Baluchistan a camp of this nature was started at Sibi, in March 1897, and still existed when we left India. The only routes by which Baluchistan can be entered are the railway and the Karachi-Somniani Kafila road which passes through miles of desert. The system adopted on the railway in the first instance had been medical inspection at frequent intervals commencing at Sibi, and the removal of all passengers exhibiting suspicious symptoms. No booking of passengers was allowed between Jacobabad and Sibi. From March 1897, all, or nearly all, native and other passengers have been treated as plague suspects, and detained for ten days for observation and disinfection. 8085-92.

At Khana, also, in Bengal, on the East Indian Railway, it was at one time the practice to treat all arrivals from infected areas as suspicious, and to detain them for the period necessary to complete ten days from the time of their departure from the infected area. This arrangement was subsequently changed to one under which only persons found to have suspicious symptoms were removed from the train and detained. 6711-2.

At the medical examination stations in Rajputana all third-class passengers from infected areas were detained, at first for ten days, and afterwards for five, before being permitted to go to their homes. Europeans and those who could be watched were not stopped. 9729-34,

At Tungabhadra, the station where passengers from the Bombay Presidency and the Hyderabad State to the Madras Presidency were examined, pilgrims from unknown areas, who could not be depended upon to state where they had come from, or where they were going to, and were very dirty, were detained for ten days. 4490-515.

(5.) Stoppage of the booking of passengers.

708. The stoppage of the booking of passengers was not often adopted, but it was adopted at several places. In some instances it was intended to defeat the attempts of travellers to evade detention or medical examination by alighting at railway stations just short of the places where these measures were carried out. In others it was used to prevent people escaping surveillance at their destination by alighting at a railway station just short of the end of their journey, and walking the remainder of it. Lastly the measure was resorted to in order to prevent the rush of infected persons into places where large concourses of people usually assemble in connexion with religious fairs or similar gatherings. In many cases, under circumstances such as these, the booking of travellers to the place of pilgrimage has been altogether prohibited as a temporary expedient. Lastly, in some cases the booking of passengers from an infected place has been prohibited, not absolutely, but in the case of persons not provided with passes from the local plague authorities.

Results of the system of medical examination. 1291.

709. At Kalyan, on the Great Indian Peninsula Railway, 3,320 persons with suspicious symptoms were removed from the trains in eighteen months; 234 had plague, of whom 50 were palpably suffering from it when found in the train. At Palghar, on the Bombay, Baroda, and Central India Railway, near Bombay, 192 persons were taken out of the train in four months, of whom 45 turned out to have plague. At Anand, 1,811 persons were removed from the trains in a period of a year. Fifteen of them had plague unmistakably developed on them when found in the train. At Bhusawal, on the Great Indian Peninsular Railway, 28 passengers were removed from the train in two years. Two of these were evidently suffering from plague at the time of their removal. At Hotgi, 579 persons were taken out on suspicion in two and half months, of whom two turned out to have plague. At Belgaum, 103 persons were removed in six months, of whom two had plague. At Hubli, out of 30 persons removed in ten months, 15 had plague, and 12 of them were unmistakably suffering from it when found in the train. At Guntakal,

5130-1, 5140. where up to the beginning of September 69,050 persons were examined, and
thereafter from 10,000 to 15,000 a week, the number of people detained as suspicious
was between February and December, 1898, 111, of whom 4 had plague.
4508-16. At Tungabhadra, on the borders of the Madras Presidency and the Hyderabad
State, 31,272 persons were examined between April and December 1898; no case of
plague was detected. The number examined in the North Western Provinces is not
6753. known, but only 2 undoubted cases of plague were detected amongst them. Lieutenant
4256-65. Cornwall examined many thousands of passengers at Malir and Karachi, but did not
discover anybody actually suffering from plague while travelling. This, however,
was while plague was in Kotri, not when it was in Karachi. At this time, moreover,
there were only a few passengers travelling. When Karachi was attacked a second
12,425-45. time, 13 passengers suffering from plague were discovered at the medical examination
8092. at Malir. The examination in Baluchistan led to the discovery of 2 cases of
plague. Between the commencement of the outbreak in Bombay and the end of
5952-6. December 1898, several hundred suspicious cases were removed from the train in the
Central Provinces and segregated. About 20 of them were found to have plague.
13,886. Seventy-seven cases of plague were detected at the railway station at Ahmedabad
between October 5th, 1896, and February 16th, 1897. At Poona in the course of
12,850-3. a year from October 1896, 61 persons were found to be suspicious on arrival at
the railway station, and 40 of them turned out to have plague. It is stated that in
12,863. the earlier part of the period the examination was not sufficiently strict. At Surat
15,544-7. many thousands were examined before the town was attacked; only 18 arrivals by
railway were detained as suspicious, of whom ten turned out to have plague. During
15,871. the second epidemic only one case was detected. In March 1897, when it became
necessary to protect Bombay against being reinfected by the return of people to their
Chap. IV. of General Gatacre's Report. homes from places in infected districts, the arrangements made for the examination of
the people returning to Bombay by railway resulted in the detection of 315 cases
of plague in a little over three months. Considerably over 1,000 persons were detained
as suspicious during this period.

Results of the system of detention camps. 710. At the twelve detention camps maintained in the Bombay Presidency proper,
131,074 passengers were detained in a period of about five months. Two
hundred and one persons developed plague. In the Anand camp 78, out of 58,000
26,537; Bombay Government Resolution 4,989 P. dated November 8, 1899. persons detained, had plague; at Kalyan, 63 out of 17,633; at Poona, 23 out of 13,670;
at Manmar, 10 out of 12,968; at Bandra 14 out of 5,790; at Igatpuri 6 out of 2,824;
at Dharwar, 4 out of 3,185; at Bhusawal, 1 out of 3,494; and at Kudchi, 1 out of 3,445;
at Londa, Gadag, and Nasik, where 4,534, 2,509, and 1,276, respectively, were detained,
no case of plague occurred.

4510, 4516. At Tungabadhra, 1,472 pilgrims were detained for ten days; no cases of plague
occurred amongst them.

4264. At the Malir camp during the first outbreak in Karachi, out of many thousands
12,429-34. detained about a dozen developed plague. In the second outbreak during the months
of April, May, and June, 1898, 7,925 persons were detained. This number includes
passengers by rail from Karachi, and also others who tried to pass beyond the camp
by road. Among the former, 95, and among the latter, 9, developed plague. Of
12,065, 12,072, 12,097, 12,100. 266 persons detained at Rohri, only one developed plague, and possibly he contracted
it from a contact camp adjoining the detention camp.

8092. In the detention camp at Sibi, in Baluchistan, one person developed plague.

6712-19. Out of 1,826,656 persons examined at the camps in Lower Bengal up to December
1898, 41,854 were detained. There were 6 cases of suspected plague, but for want of
bacteriological evidence it was not possible to decide whether any of them were true
cases of plague. How many of the 6 cases were detected on medical examination,
and how many developed the illness only after detention, is not clear.

9729. Amongst the thousands of people examined, and the large number detained, at the
different railway stations in Rajputana, 38 cases of plague were discovered; but
whether in the examination, or only in the detention camp, is uncertain.

It is not quite clear how the passengers from infected areas were treated at the
medical examination stations within the Hyderabad State. It was stated by
Lieutenant-Colonel Lawrie, I.M.S., "that no persons who are suspected of being
5151. likely to bring the germ of plague into Hyderabad, either in their bodies or their
clothing, have been permitted to enter the city, either by railway or road." About
25,912. 12,000 persons were examined every month at the three observation camps on the
railway at Wadi, Gulbarga, and Raichur, and during 18 months the number detained
5789. was 47,628. It is evident from the fact that so many were detained, while only

163 of the number had fever in the camp, that the camp was more like a detention camp than a place for medical examination only. Seventeen cases of plague occurred amongst the people detained.

Comparison of the results of detention camps and of simple medical examination.

711. Sir Andrew Wingate in his evidence before us contrasted the results when detention camps were in use, with those obtained since passengers have only been subjected to medical examination. He said :—" Last year at 12 stations, during a period of 5·14 months, 131,074 people were detained for periods varying from five to ten days. Out of those 131,000 people, 201 cases of plague were detected, and nearly 131,000 people were disinfected. . . . At 14 stations this year during a period of 3·8 months—a shorter period—116,000 people have been disinfected, against 131,000 in the previous year; and 160,000 people have been subjected to the clinical thermometer test. Out of these, nearly 12,000 people have been detained on account of a rise of temperature, and 266 cases of plague have been detected. It is too soon to say what the results in the districts may be of the re-infection from Bombay. You cannot tell that until the next two months have expired. Up to date, at all events, the proportion of the exodus of the two years is not very dissimilar, and 266 cases of plague have been caught, against 201 in the previous year; and only some 12,000 people have been detained, instead of 131,000. From what I know, I think that the medical examination has been still more thorough than the detention, and has probably led to fewer cases; I say fewer cases, because if you get a case into a camp, there have been a good many instances of cases after 9 days, 11 days, and 12 days, which seems to me to point to infection within the camp from one to another. On the other hand, by the use of the clinical thermometer, and the detention of all people who show the least temperature, 266 cases of plague have been detected, and, apparently, now the cases all develop in the first few days. These statistics seem to me indicate that there is a very small amount of risk from the exodus of the population of an infected town under precautions for carefully medically examining the people." Statistics are now available, to carry the comparison between the results of the system of detention and of that of medical examination, still further. It appears that in 5 to 7 months 261,495 travellers by railway in the Bombay Presidency were tested by the clinical thermometers, that 19,302 were detained, and that 413 of them developed plague. The number disinfected during this period was 204,312.

26,537.

Bombay Government's Resolution No. 4989 P. of 8th November 1899.

Whether the system has been the detention until the period of incubation has expired of all travellers from infected areas, or the less rigorous one of removing from the train those persons who appear, after medical examination, to be suspicious, the actual number of cases of plague which have been discovered among railway travellers while actually travelling, or under detention before they have reached their houses, has not been very numerous. So far as the results show, the less rigorous system has been quite as effective as the more severe one, and it must have caused far less inconvenience.

Indirect results of medical inspection in preventing the travelling of people likely to spread plague.

712. It is, however, claimed that the indirect results also of the medical examination of travellers and the disinfection of their baggage are very beneficial. Captain Jennings, I.M.S., who was in charge of these operations in the Bombay Presidency, urged that the measures connected with the medical examination of passengers by railway " are most useful owing to their deterrent effect against actual plague cases or people who are probably infected travelling." The figures, he said, " go to prove that very few actual plague cases are found travelling, and the probability is that all those actually suffering from plague are detected. It is only those in whose system the plague is incubating that can pass."

1297.

In referring to the fact that the medical examination of passengers by railway in the North-Western Provinces and Oudh resulted in the detection of only two undoubted cases of plague (one at Agra and one at Bareilly), Lieutenant-Colonel Thomson, I.M.S., observed, " This may seem a small result, but the preventive action of trains inspection is very great."

8753.

Sir Andrew Wingate, speaking generally of the value of railway examination, observed, " It is not only valuable because of the cases which it detects, but it is probably still more valuable in preventing sick people from leaving the infected areas. If you look at the weekly list for the Thana district, where the restrictions this year were specially relaxed compared with the year before, you will see that there were 756 imported cases in the first year and 163 imported cases last year, when there were detention camps; whereas this year the number has increased to 212 up to date. These figures are not confined to cases imported from Bombay, but indicate

26,538.

generally the variations in the number of cases imported from Bombay. In the Thana district last year there were less than 1,200 deaths, whereas this year there have already been over 3,000. The medical examination was purposely taken off between Bombay and one part of the Thana district in order to give a certain amount of play to the Bombay population, and not to tie them up too tight. The medical examination acts in those two ways,—that you catch the case that does go out, and you prevent from going out a great number of cases which would otherwise go out." 26,541. Again, he observed, "If the examination were taken off, I think that the country would be flooded with plague cases immediately."

To what extent this view is correct it is impossible to say, since, as Lieutenant-Colonel Thomson, I.M.S., has well said, 8753. "it can never be known how many infected persons or persons actually sickening with plague would have swarmed all over India, but for the knowledge that they would be subjected to inspection on arrival in fresh localities."

Question whether expense, inconvenience, and trouble involved in medical examination are compensated for by results attained.

713. On the other hand, even admitting that the results of medical examination at railway stations may have been beneficial in this respect, it appears at least to be open to doubt whether they sufficiently compensate for the expense, inconvenience, and trouble involved in maintaining the system. The results of any such system can at best amount to only a partial attainment of what is aimed at by it. The number of actual plague cases detected was very small as compared with the enormous number of passengers—many millions—who have gone through these examination stations. The only cases likely to travel to any extent are the non-infectious, mild, bubonic cases. Medical examination, even the most severe and painstaking, cannot detect a case of plague in the incubation period, and, as the ordinary period of incubation may extend to four days or more, the chances are that a person in the incubation period will escape detection if the period of his railway journey does not extend beyond one day. The number of imported cases which are known to have been brought into big towns by railway was large compared with the number detected before the journey's end was reached, and numbers of which no record exists must have been conveyed in the same way into rural areas. Any system of detention on railways must also tend to dislocate trade, to interfere with people in pursuit of their occupations, and affect the profits of the railway companies. The medical examination of passengers at particular stations produces in all probability similar results, though in a smaller degree. We have no estimate of the expenditure that has been incurred on railway examinations, but it has certainly been very large. And, in addition to the actual expenditure of money, these arrangements have involved the continuous occupation on them of many Medical Officers of all grades. The supply of qualified medical men familiar with the languages and people of India is limited, and the employment of these officers on railway examinations has naturally affected the supply of them available for employment in the suppression of plague at infected places.

Medical examination on railways can fully attain its object only if accompanied by detention for maximum incubation period and efficient disinfection; the fulfilment of these conditions cannot be secured.

714. It would be necessary, if the object is to prevent any case of plague being imported into a place by railway, to combine medical examination with the detention of every traveller from an infected area for the maximum period of incubation, and with an accurate disinfection of all personal effects. This would, in our opinion, be quite impossible. Even assuming that it would be feasible to make arrangements for the actual detention of all persons travelling, it would, we are convinced, be absolutely impossible to efficiently disinfect their personal effects. Disinfection, if imperfect, is useless; to carry it out properly is a most laborious task, requiring constant attention to details, and the thorough overhauling of each individual's baggage. We are not, we feel assured, making too high an estimate of the establishment that would be required for disinfection, when we calculate that to disinfect the luggage of 1,000 persons in a day of twelve hours, two doctors, six trained supervisors of disinfection, and a gang of about sixty men, would be required, with two large disinfecting stoves and the other necessary paraphernalia. When, as in some stations in India, many thousands of travellers have to be dealt with daily, the amount of work entailed in such a proceeding seems infinitely greater than any government could possibly undertake. It must also be borne in mind that any system of detention opens a gate to every form of fraud, corruption, and evasion. To anyone familiar with Oriental ways it would be surprising if a system for the detention of passengers by railway could be worked so as to be free from the selling of certificates, the buying of tickets at intermediate stations, the transfer of tickets from one person to another, and the bribery of subordinate officials. And, as a matter of fact, the arrangements at different places in India have been, in consequence of such practices, frequently evaded.

Conclusions regarding measures for restricting movements of travellers by railway.

715. Our conclusions in connexion with the question of placing restrictions on the movements of travellers by railway in order to prevent the spread of plague, are:—

(1) That, while the spread of plague has taken place in a very large number of cases along the railway line, the number of cases of plague detected among travellers, under the different systems adopted, has not been large;

(2) That any system of land quarantine imposed with the object of detaining all passengers from infected areas, either at a point where the infected and uninfected areas join, or at different places within the uninfected area, results in great hardship to the travelling public, and has not been found in practice to prevent the spread of plague;

(3) That in the special instance of Sibi, the objections to such a system are, owing to the fact that the traffic inwards is concentrated and easily controlled, not so great as elsewhere, while it is very important to take every precaution to prevent plague passing over the North-West Frontier of India;

(4) That any system of medical examination on railways which falls short of keeping travellers under detention for the ordinary period of incubation must be defective as a measure for stopping all infected persons;

(5) That, considering the small results attained by medical examination on railways, it is not necessary or expedient to maintain so many places for examination as hitherto: two of us, Dr. Wright and Dr. Ruffer, are of opinion that it would be well altogether to abandon medical examination on railways, except on the confines of important unaffected areas which communicate with an infected area by only one line of railway;

(6) That it appears to be unnecessary to medically examine people travelling between places within an infected area;

(7) That it may be a wise precaution, in cases where large concourses of people from infected areas are expected to go to a place for a religious festival or similar gathering, to prohibit their travelling;

(8) That the disinfection of the personal effects of travellers by railway should not be attempted because—

  (a) disinfection, if carried out at all, should be thorough, and would then cause an amount of delay and inconvenience which will not be justified by the results; and

  (b) people when themselves travelling can evade the disinfection of their personal effects by despatching them by goods train. The disinfection of articles sent by goods train would be an impossible task.

IV.(4.) *Measures to prevent the Spread of Plague by means of Communication in India other than by Sea or by Railway.*

Cordons.

716. Though not universally or even generally adopted, cordons were resorted to at certain places in India for the purpose of checking the spread of plague.

In considering to what extent cordons have been effective in checking the spread of plague, several points have to be borne in mind. One is, that in dealing for any length of time with any large number of people, there are certain individuals—such as Government servants, and, specially in the case of a trading community, persons called away on urgent business—who must be permitted to cross the line. Thus, however effectually the guards may stop everyone whom they are directed to stop, plague may be carried through by persons who are entitled to pass. Again, it must be remembered that every single person who escapes from a plague infected place may carry with him infection, which may set up a fresh epidemic. Thus a cordon, though it may not be ideally efficient and stop all the people that it ought to stop, may, if it stops some of them, be doing a certain amount of good. Lastly, the fact that plague has not spread outwards beyond a cordon is not in all cases a safe criterion by which to gauge the success of the cordon, for the existence of that cordon may have had nothing to do with the result. The people whom it was desired to shut in may possibly have been people who would not have gone out had there been no cordon. Again, the cordon may have been broken through, but it may have been broken through only by people who were free from infection or by people who, though infected, did not originate an outbreak in the place to which they went. So that the mere fact that in a few instances the disease did not extend through a cordon is not of itself conclu evidence in favour of the general efficacy of a system of cordon, as a measu preventing the diffusion of plague.

717. Having premised this, we pass on to notice the chief instances in which c have been employed.

Cordon at Umra. 2051-2.

When plague appeared in the village of Umra two miles from Surat town, Umra was surrounded by a cordon in order to prevent Surat from becoming infected. The number of people to be dealt with was only about 500. No one broke the cordon, and the infection did not reach Surat. We may note that the number of people here cordoned was very small; further we understand that a European officer was in the village to see that the guard did its duty.

Cordon at Sirohi. 9737. 9901.

There were cordons of police and sepoys to keep the people of the five infected villages in the Sirohi State from leaving their camps and going to other villages. Plague did not spread outwards from the cordoned villages to any others.

Cordon at Rohri. 12,046, 12,078, 12,083, 12,088.

A cordon was employed at Rohri, in Sind, to prevent the spread of plague into the Punjab, and, as a fact, plague did not spread from Rohri into the Punjab.

So far as these three cases go, the evidence appears to us to support the view that the cordons did prevent plague from passing through them.

Cordon at Karachi (Malir cordon). 11,130-5. 11,293. 11,300-3.

During the early part, at any rate, of the first outbreak at Karachi, the policy had been to encourage the people to leave the town and go to other places. The outbreaks in the other towns of Sind, and probably that in the North-West Provinces, were directly or indirectly due to the immigration of these people. Accordingly, when Karachi was attacked a second time, the policy was adopted of keeping the people in Karachi and its neighbourhood as much as possible. For this purpose a detention camp was instituted at Malir, a point on the railway a short distance out of Karachi. The down passengers by rail were removed from the train there and taken to the camp, and kept under observation for 10 days before being allowed to proceed. To intercept persons who might be attempting to escape by road a (11,240. 11,293-7.) cordon of police was stretched across the narrow neck of land through which the railway and the road alike run. "Karachi," Mr. Giles explained to us, "is singularly well situated for these measures. . . There is the sea on one side, and there is the desert on the other. The creeks come round to a great extent, and practically leave a small channel . . it was comparatively easy to shut Karachi in . . " (12,433-4.) Nine plague-stricken persons were intercepted by the cordon. We have no information as to the number of other persons who were prevented from passing the cordon, nor is it known whether the cordon did or did not intercept all the persons that it ought to have intercepted. It is, however, the case that infected persons did pass beyond Malir. But, while from the evidence of one witness they would seem to have (3778-9. 3822-7. 4261-2. 18,140.) been persons who had special passes exempting them from detention, or persons who developed plague after an abnormally long incubation period, another witness speaks of some, at any rate, of them as though they had succeeded in avoiding the camp and the cordon altogether. However that may be, the authorities of the places to which they went detected them before they had communicated the infection to any one there. Thus, during the time the Malir camp and cordon existed, no outbreak was originated by a refugee by rail or road from Karachi.

Cordon along Mahi river. 14,014-17. 14,193-9.

During the outbreak in the Baroda State in 1897-98 a cordon was placed along the Mahi river to protect the adjoining Bombay districts against infection. Men were stationed at every ford and place where the river was likely to be crossed, and inspectors patrolled the river and supervised the watchmen at their posts. The posts were never nearer one another than about a mile; mounted police patrolled backwards and forwards between them; and all boats were seized and detained by the authorities. (14,200.) The cordon was removed in June 1898, when the river became unfordable and plague was dying out in the Baroda State. It is alleged that plague did not cross the river while the cordon existed. It is not, however, stated that any plague-infected person was actually intercepted. There is thus no positive evidence of the success of the cordon during this period. On the other hand, when it was put on again in the middle of the following September it did, as a fact, fail to prevent infection from being brought over. We think that it would be impossible with such an establishment as was available, stationed along a length of 80 or 90 miles, to bar the passage of such a stream as the Mahi against persons determined to cross it.

We may next consider the efficiency of the arrangements made to prevent, by means of a cordon, the introduction by land of infection from Daman territory into British territory. These arrangements were not made immediately on the appearance of plague in Daman, where the outbreak, which began in February 1897, continued severe till the end of May. During the earlier period of the outbreak immigration
British territory was not interfered with, and in February and March 1897 a
exodus took place from Daman by land into, or, at any rate, through the neigh-
British districts. It was not till the 30th March 1897 that the arrangements
der consideration were made. By these arrangements it was intended to establish

a plague cordo ng the land frontier of Daman by strengthening and utilising, for the
special duty of nting refugees from Daman escaping into British villages, two lines
of guards whic e ordinarily maintained along the border. The first of these lines 11,969-77.
was that of th stoms guard, maintained for the prevention of smuggling into
British territory the other line was that of the police posts, permanently stationed
along the fronti prevent dacoits from coming over into British territory. The 15,979.
result of the spe measures adopted was that during the day there was a man at
watch at every 5 rds, while at night there was a man patrolling every 440 yards,
along the 38 mi be guarded, the vigilance of the sentries and patrols being
checked by surpr sits on the part of inspectors. From the 30th March to the 15,965.
16th April 1897, communication between Daman and British territory by land
was entirely prohi . During this period 139 persons were arrested for attempting 15,989.
to pass the cordon rom the 16th April 1897 to October 1898, intercommunication 16,608-9.
by land was perm under certain rules. In accordance with these rules, 2,768 15,993-4.
persons were det on the frontier for 10 days; four only of these persons
developed plague, he rest were permitted to cross the cordon. It is to be noted
that in the perio terior to the restriction of intercommunication, which was
enforced from the March 1897, no neighbouring British districts were infected
by refugees from an, and that after the 30th March these British districts
continued free from tion. A reason put forward to account for the absence of
infection during t riod of unrestricted communication is that the majority
of the refugees bel to Bombay and other distant places, and that even before 15,964.
the cordon was put e inhabitants of the neighbouring villages had been ordered 16,000.
not to admit strange o their villages. We think, however, that villagers could
hardly be relied upo xclude outsiders at a time when plague was so little known
as it was in the sp of 1897; and indeed, no instance could be cited in which 15,968.
village officers arrest refused to receive into their village refugees from Daman.
Moreover, with refer o the period during which communication was restricted, it
seems clear that m people may have passed the cordon without carrying the
infection and spreadi in the neighbouring districts, for, as we have seen above,
only four cases of pl occurred among 2,768 persons detained by the cordon. It
is true that no Britis lage is proved to have been infected by any person who
passed through the co but as the British territory in the neighbourhood of the
cordon remained uni d both before and after the cordon arrangements were
made, we cannot consi at this immunity is a proof of the efficiency of the cordon.
There is indeed eviden t the cordon was, to a certain extent, useful in that the
officials employed on it epted a number of persons who attempted to cross it, but
we find it difficult to b that, with only one sentry to every quarter of a mile at
night, it would be poss stop persons determined to cross the line.

Cordon at Khandraoni.

Khandraoni, a villag only 435 inhabitants, is the only place which became
fected in His Highnes Maharajah Scindia's territory. Plague had existed in this
e for two months the outbreak come to the knowledge of the authorities. 9642. 9697.
he authorities an the village was evacuated, and a cordon was put round 9648, 9669.
s in which the were lodged. The officer in charge had at his disposal a
l force of 456 s for the purpose of maintaining the cordon and watching 9693-4.
hen they we hering in their crops. The plague did not spread to any
anno te this to the cordon, however, inasmuch as only four more 9654.
don was established. This was a very small number
cases that had occurred before the establishment of the 9672.
n er village became infected. This was probably due to
nts e other villages, when they saw the heavy mortality in
ha y communication with the people of that village. We
ase handraoni, learn little as to the general efficiency of
howe note that even with a cordon of a strength such as 9669.
rovided in the most exceptional circumstances, one person is
eeded in ing through.

Cordon at Kotri. 12,603 to 12,637.

circum es of Kotri in Sind are favourable to the success of
was est hed there; the town has the Indus on one side and
the oth de. Booking at the railway stations was forbidden
passes. number of people cordoned was not large—some
he area osed was 213 acres. To guard this there were,
22 police at the different camps, a force of native troops
gth that 3 poys (with five officers) were always on duty at
ile at nigh lf-a-dozen English soldiers were employed to patrol
day the s s were 300 to 350 yards apart on the river side,

and 100 to 200 yards apart on the land side. At night the cordon was drawn
Report on Kotri by Mr. Cadell (not published with Proceedings of Commission). closer. "It was not, of course, possible," says Mr. Cadell, "to cut off all communication
with outside. The railway works constituted a great difficulty. Not only did a large
number of persons live in the town who had to go daily to their work in the railway
quarters, but the large semi-European population in those quarters needed supplies
from the town, and the cordon could not be extended round the railway. For
many other of the necessaries of daily life also, such as milk and vegetables, the
town was dependent on other places." It is a question to what extent people allowed
such liberty as this can fairly be said to have been cordoned at all. Plague did not
12,627–33. spread from Kotri. Only two people are known to have escaped, and as the presence
of the cordoned persons was checked by a roll-call it is probable that no more than
12,680. two went away. That a larger number did not go away is apparently due rather to the
hopelessness of their getting by rail to any other place than to the impossibility of
their getting through the cordon.

Cordon round chawls at Hubli. 1581–4, 2407, 20,148–53. When plague first appeared at Hubli in the railway chawls, a cordon was put round
the chawls; but the cordon could not be made absolutely efficient. The authorities
had everything in their favour, there being but a comparatively small area to enclose.
Nevertheless the infection was carried across the cordon, and it was through the default
of the police who were working the cordon that the failure occurred.

Cordon to prevent return to infected houses. 10,057, 10,529. To prevent evicted people from returning secretly to their houses, cordons were in
certain places—most frequently in the Punjab—placed round the evacuated village.
Judging from the fact that a considerable number of persons appear to have passed
through them these do not appear to have been strictly efficient.

Great majority of cordons inefficacious. 718. Whatever may be the amount of success that can fairly be claimed for the above
cordons, the inefficacy of the great majority of the cordons that have been employed
with a view to checking the spread of plague, seems clearly established. The cordon
20,229–30. that was employed round the Sadr Bazar at Sholapur was a complete failure, and yet
the authorities had what seemed a sufficient number of police, and the place was well
suited for a cordon, for it is compact, with open ground on all but one side. The
20,237. attempt to stop the people getting away from the town of Sholapur, was a still greater
failure. The inhabitants circumvented the guards and patrols posted on the roads;
they waited till night, and "crept through the fields and hedges, anywhere, and in any
way, to get away. Nothing less than a fence round the whole town would have
12,023–5. prevented them." When the town of Sukkur became infected a cordon was put on to
protect Rohri, which is just on the opposite bank of the Indus. But Rohri ultimately
9213. became infected in spite of the cordon. The situation of Hardwar and Kankhal is, it
9366. is stated, very favourable to the maintenance of a cordon. It is, however, admitted
that the cordons established there, though they were efficient to a certain extent, could
not be made absolutely efficient. Speaking of them, Lieutenant-Colonel Thomson, I.M.S.,
8782. said that it was "quite impossible in practice to maintain anything like an efficient
10,056. cordon." In the Punjab, with a view to preventing the people of infected villa
visiting other villages, it was the practice to place a cordon round the v
areas in such a manner as to allow the villagers to go out into their fie
day, while it prevented their passing beyond the areas cordoned; at nig
10,060–7. cordons were drawn in round the camps. The moral effect is said to h
considerable; it kept large numbers of people within bounds. But ther
Letter No 402/P. of 16/4/99, from Mr. French, Assistant Commissioner, Nawashahr (not reprinted). about eight guards to the mile; and it is stated that people got thr
pretext. "Time after time," writes one of the plague officers i
point in the cordon round the village of Kariam, "when I arriv
time, I found policemen off their posts or asleep." No one, we
wanted to get through and was prepared to pay would have had
10,242. through the Punjab cordons. It is also clear that many plague
10,059. as a fact, pass through them. In no less than 45 out of the 6
have been infected by human agency, was the infection brought b
have broken through a cordon. The Chief Medical Officer of t
cordons round several of the infected villages that he was dealing
thereby to have prevented plague from spreading to neighbou
13,584–9, 13,649–53. described the cordons he used as "strong" cordons, but it appears tha
at any one time more than about 10 or 12 men on duty to guard eigh
people. The existence of these cordons was apparently not know
13,501–3. Agent, who was only aware of two cordons and those in villages ot
which the Chief Medical Officer refers. The Political Agent's exp
21,299–300. cordons was that they were not of any use. When careful inquiries
the working of the cordon of cavalry put round Poona City, Ca
suburban limits, to deflect the traffic into the main roads where the m
21,328. tion took place, it was found that "anyone who chose to get through it,

night, could do so with the greatest facility. One could take a horse, or a carriage and four, through it if one wished. There was not the least difficulty."

Attempts to check the movements of the people by preventing travelling without passes.

719. In some places the cordon system was modified so that the main roads and the railways alone were guarded, people from the infected place being allowed to proceed along these only if provided with passes. Great precautions were taken to prevent people running away from the town of Surat. Passes were insisted on, and the precautions were, it is stated, successful in preventing plague from spreading out of the 24,426–7, Surat district. This contention, however, is invalidated by the fact that the pass 24,460–3. system did not prevent people from going out of Surat town into the neighbouring villages and spreading plague among these. At Bangalore the authorities were unable 2641–3. to prevent people who had not passes from going away, as the police force was very inadequate to guard all the roads, and a number of people went out at night across the fields. It would, in Colonel Robertson's opinion, have been impossible, without an enormous number of men to prevent people going away without passes. He did not think he could have made a cordon effective, even if there had been at his disposal a large number of men: "I think people who could pay would be able to get out." As a fact, over 50 villages round Bangalore became infected. At Hubli—and possibly 19,812–4. at Dharwar also—people were not supposed to go away either by road or rail, except 19,852. on passes. How the system worked at Dharwar there is no evidence to show. As regards Hubli, it was, in respect of departure by rail, presumably efficient; but in respect of departure by road it was practically useless. Many infected people from 19,825, 23,770. both places went to the villages round about and spread the disease. At Jalgaon 25,554–6. there were policemen on the roads, and a pass system; but it was not successful. "The people got away as much as they liked, and carried infection into the next taluka. The place was too big to deal with properly; one could not keep an eye on 15,000 people in the fields camping all over the place."

Road posts intended to protect uninfected places by intercepting refugees from infected places.

720. Again, when there was plague in Hubli, but, as yet, none in Dharwar, there were, Mr. Cappel says, "road posts to prevent intercourse between Hubli and Dharwar except under pass: these were doing work the whole time." How many people they stopped, and whether they stopped all that they ought to have stopped, we do not know. Before plague appeared in the Dharwar district there were road posts to guard its frontier against the adjoining infected district of Belgaum. Of their effectiveness or 1585. ineffectiveness, we are unable to judge. But the Collector says that they "undoubtedly did good, because they frightened the plague fugitives from coming in." When there 23,635. was plague in Kaladgi in the Bijapur district, all the roads leading into the neighbouring town of Bagalkot were patrolled, to prevent people from Kaladgi entering Bagalkot secretly. To what extent the patrol was efficient and of practical use there is no evidence to show. Bagalkot did not become infected.

Conclusions regarding measures to check the spread of plague by means of communication other than by sea or by railway.

721. The conclusion follows, we think, from the results of the different efforts made in this direction, that unless circumstances are very specially favourable the attempt to keep a large mass of people in or out of a particular place by means of a cordon or a similar device is doomed to failure. It must be admitted that a cordon has a moral effect, and that it may by this means deter people from passing in or out of a cordoned place unless in the case of persons who have strong motives for doing so. But, under ordinary circumstances, the physical characteristics of the plains of India, covered as they are with countless paths and tracks, present great obstacles to the success of a cordon. In certain cases, however, as at Malir, where there is virtually a *cul de sac*, or where there is a river fordable only at certain definite and well-known places, the physical difficulties are less. In such cases an attempt to restrict the movements of the people by means of a cordon may meet with some measure of success. Where, again, the infected area is very limited, and very strong establishments can be concentrated upon it, the restriction of the movement of the people by means of a cordon, if it could not be made absolute, could be made nearly so, provided that reliance could be placed on the watchfulness and the integrity of those employed on the cordon. But we fear that this is rarely the case in India; the men cannot be depended upon to remain at their posts, awake and alert; and they cannot be trusted to refuse bribes. The consequence, therefore, will almost always be that, even in the rare cases where the physical conditions are favourable to the success of a cordon, the carelessness and venality of the guards on it will bring about failure. And in the great majority of cases the area to be guarded will be so great, and the possibilities of evading a cordon at night so many, that, even with establishments which could be implicitly relied on, it will be found impossible to make a cordon an effective means for preventing the spread of plague.

V.—General Remarks on Plague Measures.

Owing to fundamental changes of conditions in India between present time and time of last outbreak in India, measures adopted in 1896 were necessarily experimental.

722. It is impossible to form a just appreciation of the operations undertaken against the present outbreak of plague in India, unless it be remembered that, previous to the commencement of this outbreak, plague had for 60 years been unknown in the plains of India. Moreover, the last outbreak, that of 1836, was purely local, and confined to Rajputana. There has, in the interval, been a fundamental change in the conditions of life within India, and in the commercial relations between that country and the rest of the world. Sixty years ago communication between England and India was slow and not very frequent; between India and other countries it was even rarer. Now, steamers arrive daily at the chief ports of India, not only from England, but also from the main trading centres of the Eastern and the Western world. Within the continent of India the opening of railways and the improvement of communication by road have entirely revolutionised the habits of the native community both in the towns and in the villages. Plague, when it reappeared in India in 1896, found both the people and the servants of the Crown in India without any practical acquaintance with its clinical or other characteristics or any recorded experience to show how an outbreak could best be dealt with in an Oriental country circumstanced as India is to-day. How different the conditions of the present time are from those of former times may be gathered from the fact that, when in 1815 a medical board was appointed in Calcutta to consider the danger of the introduction of the plague into that city, the direction from which danger was anticipated was from Arabia, and not from any part of the continent of India, though at that time plague was severe in a part of the Bombay Presidency. The various measures taken on the occurrence of the outbreak in 1896 were thus to a large extent experimental.

Every possible measure applied and tested, and every possible effort made to check the epidemic.

723. It was recognised, alike by the Government and by the more enlightened classes in India, and by public opinion elsewhere, that no reasonable measure should be left untried to prevent, if possible, the spread of plague. The feeling of one and all was that its progress must, if possible, be stopped at all hazards. But at the time no one was able to foresee with certainty how far each particular measure which appeared to be feasible and to be theoretically good could be effectively carried out in the existing conditions of native society. In these circumstances it is not surprising that not all the measures applied have been found to be beneficial, for the anticipated good effects of some of them have been more than counterbalanced by unanticipated evil effects. The evidence given before us shows that every possible experiment has been tried, and every possible effort made to restrict and eradicate the disease. If the results have not always been commensurate with the labour and expense incurred by the authorities who devised the measures, or with the trouble and inconvenience felt by those to whom the measures were applied, it must, we think, be recognised that, considering the nature of the problem with which the authorities in India were called upon to deal, this was unavoidable. If in our judgment it has appeared that all the thought, time, labour, and money devoted to the campaign against the plague have, at some places, not resulted in any great alleviation of its severity, or in the interruption of its progress, this conclusion involves no condemnation of the action taken. It is comparatively easy, on an examination of the results of a particular measure, to form an opinion of its success or failure. It was, we think, impossible to predict, when the outbreak commenced, which measure would succeed and which would not succeed. No one, however, can fail to admire the fertility of resource and the unceasing vigilance of the different Local Governments and Administrations which had to deal with outbreaks of plague, and in particular the Government of Bombay, upon which the great brunt of the work has fallen; the readiness and energy with which the rulers of Native States followed the lead set to them in British India; the zeal and devotion, not only of the officers of Government, Civil, Medical, Military, and the subordinate officials, but also of many willing unofficial helpers who have sacrificed their time, and some of them their lives, in the execution of plague duty; and the patience and fortitude of the great mass of the people in the calamity with which they were attacked.

The measures *likely to* be most successful with plague are those now adopted in all countries for infectious diseases in general.

724. In our survey of the measures taken in Indian towns and villages, we have noticed that a certain amount of success has been claimed for almost every measure, but that no single measure has been uniformly successful. We have already summed up briefly our opinion as to the degree of success or ill-success which has attended the various plague measures adopted in different places throughout the country, and it remains for us to consider the question as to what combination of measures will produce the maximum of good.

For indications as to what methods are likely to prove most successful in dealing with plague in India, we must look to the methods which have been most useful in dealing with other infectious disease in all countries. The old methods of treating an outbreak of epidemic disease—methods such as quarantine, cordons, and segregation of the contacts,—which imposed unnecessary restrictions on the healthy, are everywhere being gradually but surely given up, and in their place, notification of disease, isolation of the sick, and disinfection are being substituted, and inoculation is being resorted to as a prophylactic measure. Theoretically there is nothing to be said against the older measures and, indeed, nothing could be more well advised than to prevent people in the incubation period of disease from entering a country, or to isolate those who have been in contact with the sick, or to prevent such people from leaving an infected district, and yet these measures are in practice gradually being given up, simply because they are impracticable, this impracticability being due to the facility with which they can be evaded by healthy people. In comparison with the foregoing the measures of isolation of the sick, disinfection, and inoculation are more easily applied, provided a sufficient staff is available, and their application entails but little hardship on the friends of the patient while the inducement to hide cases is reduced proportionately.

Even with the best measures rigidly applied, danger from plague will still subsist.

725. If every case of plague could be isolated at once, and if the personal effects, clothes, and house of a patient were disinfected, and, further, if all plague-infected rats were removed and burnt, and the houses in which these had been found were disinfected, and, finally, if the healthy persons who are exposed to infection could be inoculated, the ravages of plague would be minimised. But remembering how imperfectly any measure is likely to be applied in practice, it is not to be expected that these measures, whether separately or in combination, will suffice to extirpate the disease. Isolation of the sick, for instance, can only in rare instances be applied so early that all contact of healthy people with the patient can be avoided, disinfection can not protect those already infected, and inoculation is unsuccessful in a number of cases. The fact must be faced, therefore, that there are no means of stamping out the present epidemic of plague in India, that, even with the best measures most rigidly applied, a certain amount of danger subsists, and that all that can be done is to lessen the danger as much as possible.

Staff and resources necessary for strict application of measures must soon be exhausted in a widespread epidemic.

726. A point all important in connexion with this question is that of the staff and funds available for the execution of any measures. Even supposing the funds to be practically unlimited, the time will soon come when, in any country, and especially in India, the staff available will be insufficient, and we cannot too strongly insist on the fact that, for effectively carrying out any plague policy in an extended epidemic, a reliable and enormous staff is a necessity. In illustration of this we may point to the following instances. In the North-West Provinces, the outbreak extended to one town of 16,000, two towns of about 5,000 inhabitants out each, and eight villages in their immediate neighbourhood. Excluding the Europeans, the establishments employed on plague duty in this small infected area on April 1st, 1898, comprised 92 native medical subordinates, male and female, 45 other native subordinates, 106 village watchmen, and a police force of 342 officers and men. In the Punjab, the outbreak of 1897–8 was confined to a couple of small towns and 84 villages situated in the adjoining tracts of two districts. The establishments employed in carrying out the measures against plague, exclusive of those employed in searching for plague in villages not known to be infected, were at one time, in May 1898, 16 European Medical and Civil officers, six subordinate native civil officials, 94 native medical subordinates, male and female, and a force of police of 2,872 officers and men. With establishments of this strength, and operations concentrated over a compact area in which there were no great physical and climatic difficulties, measures of compulsion were successful in preventing the spread of the infection to any considerable distance. It is impossible, however, to estimate what establishments would be required to carry out measures successfully in Calcutta and Bombay, or in places as widely infected as he Dharwar, Belgaum, Satara, Sholapur, and other districts in the Bombay Presidency were at one time or another. It appears certain that the resources of Government would be insufficient to provide establishments for the area already infected in India even if the whole of the Army, Civil, Medical, and Police establishments were employed solely on plague duties. Even for such measures as the isolation of the sick, disinfection, and inoculation, it is clear that in a badly infected district the available staff and resources will soon be exhausted, and ce it will be necessary, before adopting a particular policy in each locality, ler the staff that is available to carry out that policy.

Measures recommended for places of over 2,000 or 3,000 inhabitants.

727. It appears to us that in places containing more than 2,000 to 3,000 people—the President and Mr. Hewett are of opinion that the limit of population should be 10,000—the only measures which can be applied are disinfection, inoculation, and, possibly (so long as infection has not spread throughout the town) isolation of the sick, and the evacuation of specially infected quarters: the President considers that isolation of the sick should be carried out in all places. The value of disinfection is especially great when it is applied to imported cases or the first indigenous cases. Segregation of contacts and a general eviction of the inhabitants of large towns, have, in our opinion, done a great deal of harm. In particular, the wholesale evacuation of large towns containing a considerable artisan or trading population can be carried out only at great risk, inasmuch as the immediate result of its application will almost always be the flight of many infected people into another area, and the consequent spread of the disease. The isolation of the sick can, we are convinced, be carried out satisfactorily only when they are removed to hospital, but we see no reason why, in circumstances in which removal to hospital is impracticable, isolation should not be attempted in the patient's house. Disinfection is a measure which appears likely to influence the course of the epidemic, but it must be remembered that efficient disinfection requires not only a large staff, but a trained staff, and that throwing a certain amount of perchloride of mercury on greasy walls is not disinfection. Further, it must be remembered that, as already pointed out, houses are after disinfection liable to be re-infected by the agency either of rats or of men. It is impossible to provide against this effectively except by postponing disinfection until such time as the plague has died out both among the rats, if these have been affected, and in the human community; but this policy, though it may be carried out in places where evacuation is resorted to, is plainly impracticable in the case of large towns. In these, even though there is always a risk of the re-infection of disinfected houses, yet the advantage of destroying a considerable mass of infective material is so great as to render chemical disinfection clearly advisable. It is probable that the cost of chemical disinfection might be considerably lowered by limiting the operations to such things as really do require to be disinfected, or by adopting non-destructive methods of disinfection. It would be an advantage also, provided that the inoculations can be performed under the safeguards more particularly referred to elsewhere in this Report, to inoculate disinfecting gangs, those engaged in plague operations, and as many of those who run any risk of infection, as are willing to submit to inoculation.

Among measures of disinfection which should be carried out, the President would include the opening up of houses, wherever necessary for the introduction of a sufficiency of light and air.

In large towns in which plague cases are continuously occurring, and in which the amount of plague is subject to great seasonal variations, we think it a matter of great importance that plague measures should be carried out with especial vigour at the season when plague is at its minimum. At such a season, in view of the amount of personal supervision that could be given to each case with the relatively large subordinate staff that would be available, the chances of extirpating plague in such a a town are very much greater than at the season when the disease is most prevalent.

Measures recommended for villages.

728. In villages also chemical disinfection and inoculation should be applied; but very soon, in a badly infected district, the available staff and plant must become insufficient to cope with the work. We are of opinion that, as soon as this point is reached, chemical disinfection should be concentrated on one or two villages with a view to making it effective there, and that it should be totally abandoned in the other villages, where it would only worry people and where it could not be carried out properly. In such villages the measure which must be chiefly relied on is evacuation. In the opinion of the President the evacuation should be conjoined with an opening up of the houses sufficient for the admission of sunlight and air, wherever this is required. But evacuation carried out with an insufficient staff is, in many ways, an imperfect measure. In the circumstances it will not be possible to secure the isolation of the sick in village camps. In respect to this, nothing more can be done than to advise the people to isolate their sick. The necessity for this, with reference to certain more familiar infectious diseases, is understood by the people, and they, to some extent, endeavour to carry it out themselves. Again, evacuation with an insufficient staff is an imperfect measure, inasmuch as the evicted people carry out with them into camp plague-infected clothes and other articles, which it will be impossible to disinfect. Further, in the circumstances which we are c[illegible]dering, it will not be possible to prevent the people from revisiting their infec[illegible]uses. Lastly, in many cases there will be a risk of some of the evicted people di[illegible] spread the plague to previously uninfected

places; this risk, however, is probably small where the evicted people are agriculturists whose interests will be concentrated in their fields. Moreover, evacuation is only a cumbersome method of committing to the slow operations of nature the work of disinfection which might be efficiently carried out much more quickly by artificial means. But, in spite of its imperfection, evacuation would appear to be the only measure applicable to villages in cases where chemical disinfection cannot be applied. It is, however, to be borne in mind that climatic conditions are a most important factor in determining whether evacuation can be carried out or not. Except in a few districts in India, it appears hopeless to achieve effectual evacuation during the rains, especially in villages situated on a black cotton soil. No amount of persuasion will induce people to stay out in camp under such conditions, and they will, almost inevitably, at any rate attempt to return to their houses to sleep. The only result of an attempt to keep people out of their houses will be an immense amount of dissatisfaction unaccompanied by corresponding advantages. Whether, during the rains, evacuation could be effectively carried out on a light sandy soil depends upon various local conditions which cannot be enumerated here, but we are strongly of opinion that, before submitting people to the discomforts of evacuation, there should be no doubt that the hardships inflicted on the people will in all probability yield a balance of advantage.

Where it is found that disinfection and evacuation are both impossible, then in particular, we think that inoculation should be resorted to. Much can be done in this direction with even a small staff, for a properly trained Assistant Surgeon could in a short time inoculate the population of a village. Of course, neither in such cases nor in any other case, could inoculation by itself extirpate the plague, because a number of people will get plague in spite of inoculation.

Advisability of carrying out some one measure thoroughly, if staff not available to carry out all measures recommended.

729. We believe that by a careful application of a policy such as that outlined above, much might be done to modify the course of an epidemic, and many valuable lives would be saved. In the application of these methods, it must, however, be clearly understood that it will always be better to apply any one of them efficiently and thoroughly than to try and apply all of them with an inadequate and insufficiently trained staff. Unfortunately we cannot anticipate that India can now be freed from plague by the measures we have suggested any more than Europe has been entirely freed by sanitary measures from other zymotic diseases.

A precise statement of measures recommended by the President stated separately.

730. The President believes that a precise statement of the measures applicable at the beginning and at a later stage of an outbreak of plague in places of large and small size, respectively, would with advantage be added to the above. He has expressed his views in an Appendix* to this Report.

Attitude of people towards plague measures.

731. We may now proceed to review again the attitude of the people in its relation to the application of the plague measures dealt with above. One point which we particularly desire to emphasise is that measures which press with severity on the inhabitants of an infected place, as a whole, or on the friends and relatives of the patient as distinguished from the patient himself, can never be enforced in the case of a widespread epidemic by the staff available in India. The coercion of the people into compliance with regulations against plague is not a practical policy. But we believe that a great deal can be done by persuasion and by practical demonstrations of the utility of certain measures. A formidable obstacle to the recognition by the people of the necessity of enforcing measures against the plague is, indeed, to be found in the fatalism which the native of India shares with other Orientals. It appears to us that, though an Oriental may theoretically assert that fighting against fate is useless, this belief will not prevent him from defending his life, from calling in the native hakim when ill, or from flying from an epidemic. What he does bitterly resent is to be obliged to submit to measures, the use of which he does not understand, and of which he is naturally suspicious. Signs, however, are not wanting that, among the population that has been affected by plague, the fatalistic attitude of the people towards the plague has been modified. From the evidence placed before us, we are convinced that in parts of the country the people have begun to recognise the advantages of taking certain measures against the disease, and to appreciate the motives of the Government in taking steps for its extirpation.

Good effects of evacuation appreciated.

732. With regard to evacuation, there can be no doubt that, in many places, the agricultural population, at all events, have learned to believe in it, and they unquestionably will appreciate its good effects still more when further demonstrations are at

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* *See* Appendix V.

hand. We have seen that in some parts of India the natives evacuate their villages spontaneously on the appearance of plague or the discovery of dead rats.

Better methods of disinfection likely to lessen unpopularity of this measure.

733. Chemical disinfection, on the other hand, is a measure strongly objected to, perhaps because in India disinfection has often been inefficient, and perhaps also because it has been accompanied by other measures often extremely distasteful to the people. The methods of disinfection which have been in use have, as we have seen, sometimes entailed no little damage to the goods of the people. Pots and pans have been broken; rags have been burnt, which, although of no marketable value, may have been of value to the owner. True, the Government has paid compensation, but Orientals attach great importance to the manner in which things are done, and are frightened by anything like a display of force or violence such as is entailed in the destruction of crockery, the burning of clothes, the digging up of floors, and the breaking up of furniture. The moral effect as well as the efficacy of every disinfecting process should be considered, and, in our opinion, nothing should be needlessly destroyed. If this principle is kept in view, we may hope that the people will be conciliated to the necessary disinfecting operations.

No reason why inoculation, encouraged by persuasion, should not become popular.

734. The principle of inoculation is one with which, thanks to small-pox vaccination, the natives are to some extent familiar. They will learn to appreciate the advantages of anti-plague inoculation more and more as better results are obtained. However, in encouraging inoculation, due warning should be given that the protection which is conferred by the process is by no means absolute. In some instances where the people have not been duly warned, they have declined to have anything to do with inoculation, because some of the inoculated died from plague. In such cases people are apt to forget the good which has been achieved, and the intensity of their disappointment leads them to condemn utterly a system from which they have allowed themselves to expect too much. The people, therefore, should be distinctly told that inoculation is not by any means a certain prophylactic, but that it considerably reduces the chances of the inoculated getting plague, and that an inoculated person when attacked has increased chances of recovery, and that the process, if properly conducted, is harmless. It seems to us that attempts to make the people resort to inoculation should be limited to persuasion, and that no direct or indirect form of compulsion should be adopted. We see no reason why anti-plague inoculation, if furthered in this manner, should not become a popular measure.

Increased communications now render spontaneous disappearance of plague not so likely as in past times.

735. In view of the attitude of the people towards plague measures, and the imperfections of the measures which can be applied, we may, before leaving this subject, consider the possibility of the disease disappearing spontaneously, as it has in times past disappeared from Europe and from India. We may well hope that this may occur again in India. But we must point out that the conditions are essentially different now from what they were in former centuries, or even at the beginning of this century. Inasmuch as plague has been shown to travel along the lines of human communication, the chances of a place being infected and re-infected from any plague-stricken localities in India have increased correspondingly with the greater facilities for intercommunication. Hence the extinction of plague may possibly be a much slower process than formerly, for in every place the chances of re-infection have been increased.

With further spread of epidemic the natives of India must in the end depend for protection against plague largely on their own application of plague measures.

736. If, accordingly, plague should spread, the staff available for combating it will become proportionately smaller. Soon a time will come when the amount of supervision which can be given to each village must be very small, and nothing can be more certain than that in the end the native of India will have to depend for his protection against plague, to a very large extent, upon his carrying out the appropriate plague measures for himself. He can be prepared for this, not by the adoption of impracticable measures, such as cordons and quarantine, but by giving him practical illustrations of the good achieved by measures which experience has shown to be the most effective.

Sanitary improvements.

737. The effect of sanitary surroundings on plague has been considered elsewhere in the Report (paras. 337–365), and we have already set forth our conclusions regarding the character and extent of the sanitary improvements of which the adoption can be recommended as a measure for the suppression and prevention of plague.

The President has set forth his personal views on the subject in Appendix III. to this Report.

[redacted]HAPTER VII.

RECOMMENDATI ARDING THE ORGANISATION OF THE SA DEPARTMENT IN INDIA.

I.—Existin gements of the Sanitary Department in India.

Necessity for improving the organisation of the Sanitary Department in India.

738. In the cour r inquiry into the different questions referred to us in mexion with th of plague, we have formed some conclusions as to the essity for the t in certain directions of the organisation of the Sanitary partment in he object of dealing more effectively with outbreaks of gue and o and with the general sanitation of India. Our conclusions shall end to set down as briefly as possible.

Existing arrangements of the Sanitary Department in India.

39. The e ing arrangements of the Sanitary Department in India are as follows. office of Sanitary Commissioner with the Government of India is combined with of Director-General of the Indian Medical Service. The officer who holds these bined offices, as Sanitary Commissioner advises the Government of India on tary matters. He makes tours of inspection, in the course of which he inquires sanitary questions. His reports are made to the Government of ndia, by which directions regarding sanitary matters are given to the Loca overnments. pt through this channel, he has no authority over officials i the Sanitary rtment serving under any of the Local Governments. These latter exercise entire ol over the Sanitary Commissioners and Deputy Sanitary Commissioners serving them. Under the Local Governments in Madras, Bombay, Bengal, the North- ern Provinces, and the Punjab there is a Sanitary Commissioner, who is a er of the Indian Medical Service. These officers are charged with the duties of ng the Local Governments on all sanitary matters; of inquiring into all outbreaks of lemic disease; of controlling all operations connected with vaccination in their Pr ices; and of supervising the registration of vital statistics within them. In ea f the other Provinces the duties of Sanitary Commissioner are undertaken, in co ation with those of the supervision of Civil Hospitals, by the Inspector-General of l Hospitals. Under the Sanitary Commissioners in the larger Provinces there are arying number of Deputy Sanitary Commissioners. The largest number, viz., five employed in the Bombay Presidency. The districts supervised by the Deputy San Commissioners are in all cases so extensive that it is not possible for a De Sanitary Commissioner to visit in any one year more than a small number of the ges which call for inspection. In all Provinces, excepting Bombay, the Civil Sur , who is the Medical Officer of the district or unit of civil administration with Province under the charge of a Collector, has also to undertake the duties of Hea Officer of the district, and to advise the local civil authorities on all matters conn with sanitation. The Civil Surgeon of a district in the Bombay Presidency is no uired to undertake these duties. As a rule, no subordinate establishments are separ entertained within a district for sanitary duties, but the establishments emplo in the conduct and inspection of vaccination are utilised also in sanitary work.

Sanitary Boards.

740. tside the Sanitary Department there are, under the different Local Governments, Sanita Boards composed of a varying number of members belonging to the medical, sanita civil engineering, and civil branches of the Government's Services, with some fficial members. All the larger measures of sanitary improvement, such as projec or improvements in water supply, have to be considered by these Boards before are undertaken.

Existing arrangements regarding Health Officers.

741. the Presidency towns of Calcutta, Bombay, and Madras, European Health Officers employed by the Municipal Corporations. These officers are sometimes selecte m the Indian Medical Service and sometimes not. They are directly subject the authority of the Municipal Corporation by which they are employed.

A fe eparate Health Officers, who may or may not be members of the Indian Medical rvice, are employed also by other large Municipalities, to which they are directly ponsible. But as a general rule a Municipality does not employ a separate Health er, but is entitled by regulation to the services and advice of the Civil Surgeon his capacity as such. This rule, however, is not followed in the Bombay Preside the Civil Surgeon there having no responsibilities in connexion with Municip s.

In the f ports, Port Health Officers are employed under the orders of the Local Governm to supervise the arrangements connected with the granting of bills of health a milar matte

Sanitary Commissioners, under existing system, not necessarily sanitarians, and liable to recall to military duty.

742. It appears to us that the existing organisatio[illegible]ive in som[illegible]ery important particulars. In the first place, the system of sele[illegible] Sanitary Commissioners, who are the chief inspecting officers of the Depart[illegible]ns to be faulty. They are appointed for a term of four to seven years fro[illegible] members of the Indian Medical Service. It is not necessary that they shal[illegible]d an apprenticeship in the Sanitary Department. In selecting officers for these[illegible]tments regard is, no doubt, given to the knowledge which they possess of san[illegible]stions, but there is no guarantee that an officer selected to be a Sanitary Com[illegible]er should have made a special study of sanitary science.

It also appears to us to be a defect in the present syste[illegible]itary Commissioner should be liable to be recalled to military duty in c[illegible] it be urged that, although this liability exists, it is never enforced, it must be [illegible]ed that the Sanitary Commissioners are not an effective part of the military res[illegible] and that no harm would result from taking them out of it.

In Calcutta and Bombay, Health Department undermanned and position of Health Officers not sufficiently independent.

743. There are other points also in which the present organisation appears to us to be defective. The Health Department in towns such as Calcutta and Bombay is not sufficiently strong in Medical Officers for the duties which it has to perform even in ordinary times. It is a matter of Imperial interest that the sanitary arrangements in these cities [illegible]ld be effectively supervised and controlled, and that the medical establishments for this purpose should be adequate. It appears to us to be quite impossible for one European Medical Officer to properly perform the duties of Health Officer in the cities mentioned and the other larger towns of India. Moreover, the Health Department in these places appears to us to be at a disadvantage, not only by reason of its being undermanned, but also by reason of the position of the Health Officer not being sufficiently independent. The appointment of Health Officers at Bombay and Calcutta is made by the Municipal authorities, subject to the approval or confirmation of the Local Government. The Health Officer has no means of carrying into effect sanitary measures of essential importance if the Municipal authorities are not favourable to them.

Civil Surgeons unable, in addition to performing their other duties, to control sanitary administration of Municipalities and rural areas in their districts.

744. We have observed that the Civil Surgeon has ordinarily, except within the Bombay Presidency, to advise the Municipal Committees within his district upon sanitary matters. His ordinary duties are of a multifarious character, and often do not leave him with the leisure necessary to devote proper attention to sanitary questions even within the Municipality at the headquarters of his district. Moreover, his functions are simply those of an adviser; he has no power to carry out any recommendation that he makes. Thus, even in large Municipalities outside the Presidency towns in India, insuperable difficulties may be thrown in the way of a Civil Surgeon who is endeavouring to carry out sanitary improvements.

In his capacity as Health Officer of his district, the Civil Surgeon is hampered by the numerous duties at headquarters which prevent him from travelling about his district, and by the fact that he has no subordinates with Medical and Public Health Qualifications whom he can utilise for making visits of inspection into the interior.

No agency at present for bacteriological work.

745. Lastly, the existing organisation seems to us to be defective in that it comprises no agency for inquiries into bacteriological and other questions connected with the Public Health, with the single exception that the Chemical Examiner in the North-Western Provinces is also bacteriologist to the Local Government.

II.—Recommendations for the Reorganisation of the Sanitary Department in India.

Questions to be considered with reference to suggested improvements.

746. We would recommend that the Sanitary Service should be reorganised, and that an Imperial Sanitary Department should be established in India, somewhat on the lines which we have sketched below.

We have to consider in connexion with the proposed Sanitary Department:—

(1.) The question of the present and future recruitment of the staff of the Sanitary Department.

(2.) The question of the augmentation and strengthening of the present Sanitary Staff.

(3.) The disposal and functions of the various members of the Department.

(1.) Present and future recruitment of the staff of the Sanitary Department.

747. We propose that the following might immediately be brought on to the permanent staff of the Department:—

(*a*.) The European Medical Officers of Health who are at present in the service of the various Municipalities.

(*b*.) The Port Health Officers of Bombay, Calcutta, Karachi, Madras, and Rangoon.

(*c*.) The Medical Officers who now hold appointments as Sanitary Commissioners and Deputy Sanitary Commissioners of the different Provinces.

(*d*.) The bacteriologists who are now in the employ of the Indian Government.

(*e*.) Civil Surgeons and their Assistants, in so far as they perform sanitary duties, and the staff of the Vaccination Department.

With regard to the future recruitment of medical men for the permanent staff of the Department, we would suggest that, as the services of men of special training and ability will be required, the emoluments of the appointments in the Department should be fixed on a scale sufficiently liberal to attract men of the class required, and that these appointments should be opened, on the one hand, to officers of the Indian Medical Service who have gone through a special course of training, and, on the other hand, to other medical men who have special Qualifications in Public Health. In the case of appointments from the Indian Medical Service, we would suggest that the appointments might, with advantage, be limited to officers of less than seven years' service, provided that before assuming duty they shall have studied Public Health in courses equivalent to the requirements for Degrees or Diplomas in Public Health.

(2.) The augmentation and strengthening of the present Sanitary Staff.

(*a*.) Medical Officers of Health.

748. We consider that the administrative Department as thus constituted would urgently require to be strengthened in several directions. We think that it ought, in the first place, to be strengthened by the appointment of a number of additional Medical Officers of Health. We would recommend that a special European Medical Officer of Health should be attached to every city in India which contains a population of more than 100,000 inhabitants. And, inasmuch as the limit of population which a single Medical Officer of Health is capable of supervising effectively may be fixed at 100,000 inhabitants, we propose that in the case of cities one European Assistant Health Officer should be provided for every 100,000 inhabitants in excess of the limit specified above. We think that, while the Municipalities to which Medical Officers of Health may be appointed in accordance with our recommendations should provide for the salaries attached to the appointments of such Officers and their Assistants, they should not have the power of nominating to these appointments or that of removing officers who have been appointed.

(*b*.) Special scientific officers.

Further, we would recommend that the staff of the Sanitary Department should be strengthened by the recruitment of a number of specially trained Medical Officers to fill the various scientific posts which ought, in our opinion, to be created.

(*c*.) Chemical Examiners.

Again, it might be useful to include the Chemical Examiners in the staff of the Department, in order to have available within it officers capable of conducting chemical analyses; but the duties which the Chemical Examiners have to perform in connexion with medico-legal work may possibly be an obstacle to this being done.

(*d*.) Civil Surgeons.

We think that the Civil Surgeon in the Bombay Presidency should be given similar duties in respect of sanitary matters to those which are entrusted to the Civil Surgeon in other Provinces.

(*e*.) Assistant Surgeons.

In order to assist the Civil Surgeon in his duties of Health Officer of the district, it is desirable that an Assistant Surgeon, qualified by his knowledge of hygiene, should be appointed in each district. This Assistant Surgeon could be employed at times in temporary charge of the Hospital at the district headquarters so as to admit of the Civil Surgeon making tours of inspection in the interior of the district; and at other times the Assistant Surgeon could himself be engaged on the duty of making such tours. For these purposes men of special attainments and quali[redacted]tions would be required, and we think that, as a preliminary to their [redacted]e Sanitary Department, a certain number of them might be employ[redacted] the [redacted]rades of what is now the Vaccination Department, where their qua[redacted]ns and [redacted] could be tested.

(*f*.) [redacted]

Inasmuch as the Inspectors and Superintendents o[redacted] arrangements, no medical qualifications and no spe[redacted] acquire in the course of their employment in the [redacted] be of great advantage from a sanitary point of vie[redacted] Assistant Surgeon[redacted] to the position of Inspectors or Superintendents of [redacted]nation. Under such an arrangement the work of vaccination would not be[redacted]fficiently performed than heretofore, while that of the Sanitary Department wou[redacted]materially improved.

(3.) The dis[redacted] of the various members of the Sanitary Department.

749. With regard to the disposal of the staff, [redacted]ows from what has been said above that the various members of the Depa[redacted] should fill the posts (*a*) of Medical Officers of Health to the larger cities, [redacted] Medical Officers of Health to the various sub-divisions of each Province [redacted]sidency, (*c*) of Port Health Officers to the various large ports, and (*d*) of ad[redacted]rative or supervising officers.

In addition, we propose that a certain number of members of the Department should be employed on scientific investigations in connexion with important questions of Public Health; and the President proposes that a certain number, also, should be employed both in scientific investigations and in the teaching of Public Health, as explained in paragraph 754 below.

Functions of Medical Officers of Health.

750. We do not think that it is necessary here to attempt anything in the way of an enumeration of the various duties which should be undertaken by the Medical Officers of Health. It will suffice if we advert to certain duties which appear to us to be particularly important.

(*a.*) Sanitary control over lodging-houses and the erection of houses.

We have already, in connexion with the consideration of the influence of insanitary conditions on the severity of plague epidemics in India, adverted to the fact that the condition of many of the dwelling-houses in the large towns in respect of overcrowding and in respect of structural defects is such as to make a healthy existence in them practically impossible. In connexion with the duties of Medical Officers of Health of large cities, such as Bombay or Calcutta, we would particularly emphasise the importance of exerting a sanitary control over lodging-houses for the prevention of overcrowding. We are of opinion that structural defects might slowly, but effectually, be remedied, at any rate in the larger towns, if the Medical Officers of Health were empowered to veto the erection or the rebuilding of grossly insanitary buildings within the limits of the Municipalities to which they were attached. The President, however, is of opinion that the prevention of "overcrowding," in so far as this implies a limitation in the number of the occupants of rooms based merely upon their cubic capacity, can, at present, have little beneficial result; for in the great majority of the dwellings, whether lodging-houses or not, a reasonably pure air would not thereby be secured, on account of structural defects and insanitary surroundings. He considers also that the remedying of the prevailing structural defects of existing buildings urgently requires attention, and that the measures which are being carried out with this object in Calcutta, Bombay, and other cities and towns, should be continued and extended.

(*b.*) Collection and scrutiny of accurate death reports.

751. Another of the most important duties of all Medical Officers of Health, whether in the large cities or in the districts, will in our opinion be the duty of collecting accurate death reports. It ought to facilitate the introduction of sanitation into the villages and towns if provision were made that weekly reports of death should in all cases be sent in to the Civil Surgeon as Medical Officer of Health for his district, with a view to their being carefully scrutinised in order that the existence of plague or any other epidemic disease may be brought to light. In the event of any serious mortality being detected by this method in the villages or towns, we think the authorities at the Head Quarters of the Sanitary Department should be immediately informed, and that inquiries into the cause of the excess of mortality should be instituted without delay. For this purpose we think that the Assistant Surgeons whom we have proposed to attach to the vaccinating staffs might very appropriately be utilised.

(*c.*) Measures against plague and other infectious diseases should be undertaken with advice and under control of members of the Sanitary Department.

752. Again, one of the most important of the functions which we would propose to entrust to the Medical Officers of Health (including Civil Surgeons acting in this matter under the directions of the Sanitary Department) is the duty of advising with regard [redacted] all measures taken with a view to combating plague and other infectious [redacted] We consider that the functions of the Medical Officer of Health ought not [redacted] advising. We propose that the direct conduct of the [redacted] are [redacted]ken should, so far as this does not involve an abdication of [redacted] the [redacted] the Civil Officer, be entrusted either to the Municipal [redacted] Health Officers who are now styled Deputy Sanitary [redacted]rgeon in his capacity of District Health Officer. [redacted]r any reason, unavailable for the duty, we suggest [redacted]y Department should be deputed to take charge of [redacted]e operations.

In advocating that [redacted]tions should be under the direct supervision of Medical Officers who are members [redacted]anitary Department, or who are acting under instructions from the Sanitary [redacted]t, we are advocating a definite departure from the practice of committing the [redacted]t of plague operations to Civil as distinguished from Medical Officers. We [redacted] however, in connexion with this, point out that what we advocate is merely [redacted]practice which has long been adopted in connexion with the vaccination operations [redacted]ed against small-pox in India should be extended to the operations which are [redacted]ce against plague and other epidemic diseases. We are convinced that in the [redacted]ague, just as in the case of small-pox, efficiency can be secured only by placing the staffs and the general direction of the operations under the control of medical men who possess the necessary technical knowledge. While we are convinced of this, we, as we have indicated above, do not fail to recognise that, just as a veto is reserved for the civil administrator in cases where the undertaking of vaccination operations may involve political or financial considerations, so it will, on both these grounds, similarly be necessary in the case of plague operations, and we recognise that the veto will be more necessary in the case of plague than in the case of small-pox, where circumstances seldom call for its exercise. Subject to this necessary veto, and, of course, to the provision that the local Civil Authority must, with a view to exercising that veto, always be fully informed beforehand of the exact nature and extent of the operations which it is proposed to undertake, we think, as stated before, that the conduct of the operations ought in all cases to rest with the Sanitary Officer.

Among the things which impressed us most in India was, first, the utter absence of a uniform system of dealing with plague, and, secondly, the fact that very little of the experience which was gained in one place was rendered available for use in another. This absence of uniformity was seen not only in the case of general plague policy, but it was seen also, and even more glaringly, in connexion with matters of a purely technical character. We have referred in our survey of the disinfection operations to the futility of many of the methods which were adopted and to the technical errors which were repeated over and over again in scores of different places. And this was necessarily so, for the officers in charge of the plague operations in each place had to work out for themselves a system of disinfection quite regardless of the experience which had been gained in other places. While we have nothing but admiration for the zeal and energy which was everywhere displayed, we are of opinion that there was much misdirection of effort. Now this could in large part be remedied by securing that the direction of plague operations, and in particular the direction of technical matters in connexion with those plague operations, should be placed in the hands of an Imperial Sanitary Department.

Mr. Hewett and Mr. Cumine dissent from the above paragraph.

Mr. Hewett and Mr. Cumine do not concur with the above remarks. They do not agree with the recommendation made in this paragraph that the Medical Officer of Health of a Municipality or some other member of the Sanitary Department should, so far as this does not involve an abdication of authority on the part of the Civil Officer, invariably have the direct control of all measures undertaken to combat plague and other infectious diseases. They think it sufficient to point out that there may be—and in their opinion there often are—reasons which make it advisable to place in charge of the actual operations against plague an officer other than a Medical Officer.

(*d.*) Necessity for establishment of bacteriological laboratories.

753. So far we have dealt only with the functions of the administrative as distinguished from the scientific branch of the Sanitary Service. The functions of this last branch are in our opinion not less important in their way than the functions of the administrative branch. To this branch would naturally be committed the bacteriological diagnosis of doubtful cases of plague or of other epidemic disease, the conducting of experiments to determine the effect of various disinfectants and to determine the mode of life and history of the various pathogenic agents, the mode in which these effect an entrance into the organism, and many other questions of similar nature. Further, there would naturally be committed to this Department, the manufacture of anti-plague and anti-small-pox vaccine, and of all other vaccines which may prove themselves to be effectual in the prophylaxis of disease. The efforts of the Department might, we think, usefully be directed also to the endeavour to produce thoroughly effective sera for the therapeutic treatment of plague and other infective fevers and of snake poisoning.

We think that it might be well to concentrate the manufacture of vaccines and therapeutic sera and the special study of questions relating to these in a Central Institute of Public Health, which for climatic considerations ought, we think, to be situated somewhere in the Hills, in a place readily accessible by rail. Without this the utility of a central laboratory would be curtailed in many ways. Such a central laboratory in the Hills would, however, not be available either for clinical research or for the study of the conditions under which pathogenic micro-organisms exist in the different parts of India. Neither would it, on account of the distances to which material woul have to be sent, be available for the bacterial diagnosis of doubtful cases of disease different parts of the country. We are, therefore, of opinion that it is essentia Public Health laboratories should be established in the chief town Presidencies and Provinces, and these laboratories ought, we thi not only with a view to their being utilised for directly practical purposes, but also with a view to their being utilised for purposes of research. These laboratories might with advantage be established in connexion with the Medical Schools of the selected towns, where they could be utilised also for teaching purposes.

Remarks by the President on the advisability of improving and extending teaching in Public Health.

754. In the opinion of the President this utilisation of the Public Health Laboratories would greatly increase their scientific usefulness, while the efficacy of the teaching carried on in them would be enhanced by the association with research work. The President has elsewhere* pointed out that insanitary conditions exist in the rural as well as urban districts which urgently call for improvement, and in his opinion these conditions are in great measure caused by want of information on the part of the people regarding the most simple and elementary requirements for healthy existence, with the result that, irrespective of deaths produced by infectious diseases, the general mortality from other preventible diseases is extremely high. As Native practitioners are brought into closer relationship with the people than European practitioners, the President, considering that they are thus more frequently in a position to give simple and elementary, but still valuable, instruction and advice to Natives in matters pertaining to healthy existence, and being of opinion that the recommendation above made to employ Assistant Surgeons in sanitary work would largely depend for its success upon the thoroughness of their education in Sanitation, deems that it is advisable to improve and extend the teaching of Public Health in the Medical Schools where the Native Medical Practitioners and Assistant Surgeons are educated. This might, the President thinks, best be done, and thereby much benefit conferred upon the people of India, by—

(a) restricting the Public Health teaching appointments in the Medical Schools to professors or teachers specially qualified in the subject;

(b) providing that the Public Health laboratories recommended to be established in each Presidency and Province should be attached to the chief Medical School of the Presidency and Province, and should be properly equipped not only for purposes of clinical and scientific research, but also for practical instruction in Public Health; and

(c) requiring that all candidates for medical degrees or licences should go through a course of effective practical instruction in one of these laboratories, in addition to the qualifying course of systematic lectures in Public Health elsewhere attended.

Organisation of the permanent staff of the Sanitary Department.

755. Our recommendations with regard to the organisation of the Sanitary Department are as follows:—

(1.) We recommend that all the members of the Sanitary Department should be borne on one list.

The provision that the members of the Sanitary Department should all be borne on one list would have great advantages in facilitating the training of Medical Officers of Health. Another advantage would be that it would be possible to transfer a member of the Sanitary Service, who had gained experience in connexion with a particular epidemic disease or a particular sanitary measure, to any locality where that experience might be required. A further advantage would be that stagnation would be avoided and that active and tactful Medical Officers of Health would find fresh stimulus to exertion in the knowledge that their work would come under expert scrutiny, and that promotion to a higher post would be open to them.

(2.) We recommend that all appointments in the Sanitary Department should be made by the Head of the Department, subject to the approval of the Local Government, and that all the members of the Sanitary Department, whether engaged on executive duties as Medical Officers of Health or on exclusively scientific or scientific and teaching duties relating to Public Health, should be placed directly under the orders of the Head of the Sanitary Department; and one or more inspecting Medical Officers of Health might, we think, be appointed to assist the Head of the Sanitary Department in his work of supervision.

In support of this recommendation, we point out that the organisation of all Medical Officers of Health under the orders of a single Head would ensure, first, that the experience gained in one place could be utilised in another; and, secondly, that all easures which were adopted throughout India for combating infectious diseases uld be carried out with the same degree of efficiency, and should be informed by nd the same plan and purpose.

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* *See* Appendix No. III.

Mr. Hewett and Mr. Cumine are unable to concur with the recommendation that the members of the Sanitary Department should all be directly under the orders of the Head of the Department. They see no objection to the officers employed exclusively on purely scientific duties being placed directly under the supervision and control of the Sanitary Commissioner with the Government of India on the understanding that they would be required to undertake enquiries at the direction of the Local Governments. The executive officers, however, of the Sanitary Service, whether employed as Sanitary Commissioners and Deputy Sanitary Commissioners—to use the designations hitherto used for them, which seem to be suitable—or as Health Officers within Municipalities should, in the opinion of Mr. Hewett and Mr. Cumine, be subject to the orders and control of the Local Governments, and not to those of any outside authority. The complete subordination of members of the Sanitary Service to the Local Government under which they may happen to be serving is not in any way inconsistent with their being placed on one list and being liable to serve in any part of India. The Government of India would place an officer at the disposal of a Local Government, and, until they removed him from its control, he would remain entirely under its authority. As Mr. Hewett and Mr. Cumine understand the proposals of the majority of the Commission, they would have the effect of taking away from the Local Governments the control over sanitary matters within the territories administered by them. Any curtailment of the powers of the Local Governments in these matters seems to Mr. Hewett and Mr. Cumine open to the greatest possible objection, as it would result in the centralisation of the control of measures adopted against epidemics in the hands of the Government of India, who have neither the leisure nor the local knowledge to carry out such control as efficiently as Local Governments can.

✓(3.) We recommend that the Head of the Sanitary Service should occupy the position of Sanitary Commissioner to the Government of India. In view of the new administrative duties, which we would propose to commit to this Officer, the majority of us think that the office of Sanitary Commissioner to the Government of India should be erected into a separate office, and that it should not, as at present, be held in conjunction with the Director-Generalship of the Indian Medical Service. We consider that, besides controlling the Sanitary Service and advising the Supreme Government on all matters relating to Public Health, the Sanitary Commissioner should inform himself, as far as necessary by personal visitation, regarding the insanitary conditions, sanitary action, and prevailing diseases in all parts of India; that he should review the work of the scientific sanitary establishments; and that he should prepare an annual report dealing with these subjects. In order that his duties may be efficiently performed, we also consider that he should be provided with an adequate Medical and Clerical Staff, and be supplied with reports bearing on the above-mentioned subjects, especially including reports on Sanitation and on Vital Statistics, from each of the Presidencies and Provinces.]

Mr. Hewett and Mr. Cumine agree that if the Sanitary Commissioner with the Government of India is given all the duties suggested for him in this Chapter, it will be necessary to separate his office from that of the Director-General of the Indian Medical Service. They are, however, not satisfied that, if the position of the Sanitary Commissioner remains as it is now, the separation of his office from that of the Director-General of the Indian Medical Service will be necessary. Some advantage, they think, might indeed result from such separation, but the union of the two offices is economical, and this aspect of the question must not be overlooked.

[(4.) In view of the importance of the functions of the Sanitary Department and of the Imperial interests which are involved, and in view of securing that absolutely independent advice on sanitary matters should be placed directly before Government in a country, where, owing to the absence of independent medical public opinion, too much weight is likely to be given to the possibility of administrative difficulties arising in the carrying out of sanitary measures, and finally, with a view to avoiding the delays incidental to the submission of proposals to Government through an intermediary, we recommend that the Head of the Sanitary Department should be made a Secretary to Government.]

The President considers that, if questions of administration should raise important difficulties against the adoption of the above recommendation No. (4), however desirable it may be in the interests of sanitation, the following should be proposed as an alternative, viz.:—that the Head of the Sanitary Department should have the right, on all occasions in which he deems it expedient, personal[illegible]is proposals and explain his views to the Member of His Excellency the Viceroy's Council dealing with matters relating to Public Health.

Mr. Hewett and Mr. Cumine see no reason to alter the position of the Sanitary Commissioner with the Government of India, which is that of adviser to the Supreme Government in sanitary matters. He has already free opportunities for stating his views both in writing and verbally to the Member of Council in charge of the Department dealing with Public Health, but for the adoption or rejection of those views the Supreme Government alone can be responsible.

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APPENDIX No. I.

Statistics relating to certain Clinical Characteristics of Plague.

I.—General Case Mortality.

A.—Trustworthy Figures relating to Places in which all Cases and their Results probably came on to the Record.

Authority for Figures.	Place of Observation.	Number of Cases.	Number of Deaths.	Percentage Case Mortality.	Remarks.
Evidence, 10,330 -	Punjab -	2,706	1,697	62·7	
„ 13,159 -	Palanpur -	815	503	61·7	
„ 9539–40 -	Jawalapur -	116	93	80·1	
„ App. LXXXVIII., Memorandum A.	Byculla Jail -	25	12	48	Uninoculated only.
Evidence, App. LIX.	Umarkhadi Jail -	16	9	56·2	Uninoculated only.
	Total - -	3,678	2,314	62·9	

B.—Fairly Trustworthy Figures, probably affected to some extent by the Omission of Mild Cases, while Severe and Fatal Cases have generally been brought on the Record.

Authority for Figures.	Place of Observation.	Number of Cases.	Number of Deaths.	Percentage Case Mortality.	Remarks.
Evidence, 14,214 -	Ankleshwar Town -	331	245	74	
„ 14,214 -	Ankleshwar Villages	96	60	62	
„ 14,637 -	Baroda City - -	1,582	1,304	82	Uninoculated only.
„ II. 517, App. R.	Baroda Villages -	1,118	853	76	The principal villages only.
„ 15,424–6 -	Baroda Cantonment -	119	94	79	Uninoculated only.
„ 14,482 -	Bhiwandi - -	1,788	1,255	70	
„ 13,692 -	Porbandar - -	465	357	77	
„ III., 90 -	Igatpuri - -	512	411	80	
„ III., 90 -	Ilkal - -	284	238	84	
„ II., 233 -	Umreth - -	110	91	83	
„ 12,649 -	Kotri - -	100	68	68	
	Total - -	6,605	4,976	75·3	

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C.—HOSPITAL FIGURES, which do not take account of all SEVERE CASES (such as those resulting in death before Discovery by the Authorities) or of all MILD CASES.

Authority for Figures.	Hospital.	Number of Cases.	Number of Deaths.	Percentage Case Mortality.	Remarks.
Evidence, III., 457 -	Bombay, Arthur Road	3,919	2,800	71	
Gatacre's Report, p. 111 ; Campbell's Report, p. 134.	Bombay, Grant Road	1,575	1,177	74	
Gatacre's Report, p. 48 ; Campbell's Report, p. 115.	Bombay, Parel -	1,296	684	52	
Hospital Report for period from 1/6/97 to 31/3/98.	Poona General Hospital	4,179	2,836	67	
Evidence, 25,024, 25,027.	Bangalore and Mysore	3,834	2,505	65	Uninoculated only.
	Total - -	14,803	10,002	67·5	

Dr. N. H. Choksy, of the Arthur Road Hospital, Bombay, after collecting the records of about 11,600 cases in the various Plague Hospitals of Bombay, arrives at the conclusion (Bombay Medical and Physical Society, September 1900) that in 1896–97 the average hospital case mortality ranged from 61·53 to 68·28 per cent. in different hospitals ; that in 1897–98 it ranged from 78·55 to 79·26 per cent. ; that in 1898–99 it ranged from 78·97 to 81·40 per cent ; and that in 1899–1900 it ranged from 79·54 to 80·95 per cent. From these figures, by a process which is not plain to us, Dr. Choksy concludes that " the normal mortality rate of plague in our public hospitals may safely be put down at 80 per cent."

II.—GENERAL CASE MORTALITY AS INFLUENCED BY SEX.

Authority for Figures.	Place of Observation.	Male.			Female.		
		Cases.	Deaths.	Case Mortality per cent.	Cases.	Deaths.	Case Mortality per cent.
Gatacre's Report, pp. 48, 52, 111, 124 - - - Campbell's Report, pp. 139, 141, 151 - - - Evidence, III., 459 - -	Bombay Hospitals	5,047	3,664	74·5	1,455	1,202	82·6
Hospital Report for period from 1/6/97 to 31/3/98 - -	Poona General Hospital.	1,705	1,244	72·7	1,697	1,152	60·6
Evidence, II., 424 - -	Karachi - -	2,174	1,707	78	1,064	828	77·5
" 13,159 - -	Palanpur -	290	188	64·7	382	238	62·3
" II., 484 - -	Porbandar -	91	63	69·2	113	62	55
" 15,645 - -	Surat - -	78	57	73	36	26	72·2
" 12,649 - -	Kotri - -	65	43	66·2	35	25	71·5
" 14,047 - -	Umreth - -	64	52	81·1	46	39	85
" I., 474 - -	Calcutta - -	152	126	83	38	29	76·5
	Total - -	9,666	7,144	73·9	4,866	3,601	74·0

Dr. N. H. Choksy, of the Arthur Road Hospital, Bombay (Bombay Medical and Physical Society, September 1900), gives the following tabular statement of observations made in the Bombay Plague Hospitals, in 6,000 cases (more than 5,000 being cases of Hindus), regarding the influence of sex and age on case mortality :—

Case mortality per cent. in Bombay hospital cases.

Class.	Males.	Females.	Children.	Total.
Hindus - - - -	79·71	77·47	69·57	75·33
Muhammadans - - - -	64·76	78·04	58·82	65·73
Native Christians - - -	63·77	68·36	58·97	64·34

III.—General Case Mortality as Influenced by Age.

Authority for Figures.	Place of Observation.	Age Periods.	0–5.		5-10.		10–20.		20–30.		30–40.		40–50.		50–60.		Over 60.	
		Total Cases observed.	Cases.	Case Mortality per cent.	Cases.	Case Mortality per cent.	Cases.	Case Mortality per cent.	Cases.	Case Mortality per cent.	Cases.	Case Mortality per cent.	Cases.	Case Mortality per cent.	Cases.	Case Mortality per cent.	Cases.	Case Mortality per cent.
Evidence, III., 459	Bombay, Arthur Road Hospital.	4,000	57	57·8	188	66·4	714	66·6	1,333	70·5	1,028	69·2	414	83	168	86·9	98	85·7
Gatacre's Report, p. 111 ; Campbell's Report, p. 140.	Bombay, Grant Road Hospital.	1,230	34	70·5	99	80	249	74·2	457	73·6	231	89·9	104	80	40	75	16	43·7
Evidence, 10,330	Punjab	2,706	199	68·3	310	59·6	634	57·8	599	57·5	420	64·7	268	69·7	190	74·2	86	62·7
„ 12,343	Karachi Hospital	515	21	33·3	57	65	100	60	173	54·9	93	60·2	42	64·3	20	80	9	55·6
	Total of above	*8,451*	*311*	*64*	*654*	*68*	*1,697*	*64*	*2,562*	*67*	*1,772*	*69*	*828*	*77*	*418*	*79*	*209*	*76*
															50 and over.			
Campbell's Report, p. 156	Bombay, Mahratta Hospital	650	11	63·6	67	74·6	127	78	276	85·8	108	90·7	32	84·3	29		86·2	
Evidence, 12,649	Kotri	100	4	0	14	71	35	57	19	78	13	84	8	75	7		43	
		Age Periods.	0–10.				10–20.		20–30.		30–40.		40–50.		50–60.		Over 60.	
Evidence, II., 200	Palanpur	815	96		52		210	58·2	186	59·2	148	62·2	92	75	61	72	22	72·7
„ II., 233	Umreth	110	19		73·7		22	95·6	22	82	19	89·5	20	75	8	75	—	—
		Age Periods.	0–5.		5–10.		10–20.		20–40.				40–60.				Over 60.	
„ I., 474	Calcutta	183	6	50	8	87·5	39	66·7	81		86·5		36		89		13	77
		Age Periods.	0–5.		5–15.		15–25.		23–35.		35–45.		45–55.		Over 55.			
„ II., 484	Porbandar	465	14	57	128	69	113	73·5	90	86·7	51	78·6	41	85·3	29		89·2	

IV.—RELATIVE FREQUENCY OF BUBONIC AND NON-BUBONIC PLAGUE.

Authority for Figures.	Place of Observation.	Total Cases Observed.	Bubonic Cases.		Non-bubonic Cases.					
					Pneumonic.		Septicæmic.		Total	
			No. Observed.	Per cent. to Total Cases observed.	No. observed.	Per Cent. to Total Cases observed.	No. observed.	Per Cent. to Total Cases observed.	No. observed.	Per Cent. to Total Cases observed.
Evidence, III., 458	Arthur Road Hospital, Bombay.	2,723	2,463	90·5	110	4	150	5·5	260	9·5
Campbell's Report, p. 138.	Grant Road Hospital, Bombay.	798	671	84	88	11	39	5	127	16
Campbell's Report, p. 141.	Mody Khana Hospital, Bombay.	724	535	74	143	20	46	6	189	26
Campbell's Report, p. 150.	Jain Hospital, Pinjrapole.	510	435	85	32	6·5	43	8·5	75	15
Evidence, 9539–40–3.	Jawalapur -	116	81	70	19	16	16	14	35	30
Total - - -		4,871	4,185	86	392	8	294	6	686	14
Hospital Report for period from 1/6/97 to 31/3/98.	Poona General Hospital.	4,146	3,152	76	—	—	—	—	994	24
Evidence, 10,198 -	Punjab - -	3,128	2,608	83·5	—	—	—	—	520	16·8
Grand Total - -		12,145	9,945	81·9	—	—	—	—	2,200	18·1

Dr. N. H. Choksy, of the Arthur Road Hospital, Bombay (Bombay Medical and Physical Society, September 1900), classifies 11,600 cases of plague observed in the Plague Hospitals of Bombay as follows :—

Type of cases.	Per cent. to total cases observed.
Simple bubonic cases (including cases of pestis minor) - - - - - -	78·15
Septicæmic cases - - - - - - - - - -	14·25
Pneumonic cases - - - - - - - - - - -	4·10
Atypical and mixed cases (and cases with necrosis of the skin after the development of a specific plague rash) - - - - - - -	3·50

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V.—RELATIVE FREQUENCY OF BUBONIC AND NON-BUBONIC PLAGUE AS INFLUENCED BY SEX.

References same as in Table IV.

Place of Observation.	Males.				Females.			
	Total Cases.	Percentage.			Total Cases.	Percentage.		
		Bubonic.	Pneumonic.	Septicæmic.		Bubonic.	Pneumonic	Septicæmic.
Grant Road Hospital, Bombay.	529	83	11	6	269	85·5	1·5	3
Mody Khana Hospital, Bombay.	491	75	19	6	233	72	20·5	7·5
Jain Hospital, Pinjrapole, Bombay.	417	84	9	7	93	89	4·5	6·8
Poona General Hospital	1,724	73	27		1,605	81	19	

VI.—CASE MORTALITY AS INFLUENCED BY THE BUBONIC OR NON-BUBONIC FORM OF PLAGUE.

References.	Place.	Total Number of Cases observed.	Case Mortality, Per Cent. in							
			Bubonic Cases.		Non-bubonic Cases.					
					Pneumonic.		Septicæmic.		Total.	
			No. of Deaths.	Case Mortality per cent.	No. of Deaths.	Case Mortality per cent.	No. of Deaths.	Case Mortality per cent.	No. of Deaths.	Case Mortality per cent.
Evidence, III., 458	Arthur Road Hospital, Bombay.	2,723	1,730	70·2	105	95·4	102	68·0	207	79·5
Campbell's Report, p. 138.	Grant Road Hospital, Bombay.	798	569	85	87	98·8	39	100	126	9
Campbell's Report, p. 141.	Mody Khana Hospital, Bombay.	724	399	75	123	86	32	69·5	155	82
Campbell's Report, p 150.	Jain Hospital, Pinjrapole.	510	213	72	25	78	43	100	68	91
Evidence, 9539–40–3.	Jawalapur - -	116	59	72·7	19	100	15	94	34	92
Total - - -		4,871	3,070	73·3	359	91·5	231	78·5	590	86·0
Hospital Report for period from 1/6/97 to 31/3/98.	Poona General Hospital.	4,146	2,102	66·6	—	—	—	—	734	74
Evidence, 10,198. -	Punjab - -	3,128	1,509	57·4	—	—	—	—	366	70
Grand Total - -		13,145	6,681	67·2	—	—	—	—	1,690	77

Dr. N. H. Choksy, of the Arthur Road Hospital, Bombay (Bombay Medical and Physical Society, September 1900), records the following summary of observations made in the Bombay Plague Hospitals from 1896–97 to 1899–1900 :—

Type of Plague.	Number of Cases Observed.	Case Mortality per cent.
Bubonic - - -	9,500	77·25
Pneumonic - -	514	96·69
Septicæmic - - -	1,562	89·62

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VII.—RELATIVE FREQUENCY OF BUBOES, IN CASES OF BUBONIC PLAGUE, IN VARIOUS SITUATIONS, WITH THE CASE MORTALITY ASSOCIATED WITH THE SITUATION OF THE BUBOES.

(1.)—*Arthur Road Hospital, Bombay.*

(*See* Evidence, Vol. III., p. 458.)

Situation of Bubo.	Number of		Percentage of	
	Cases.	Fatal Cases.	Cases to Total Bubonic Cases.	Case Mortality.
Head and neck - - - - -	240	178	9·7	74
Axilla and upper extremities - -	439	322	17·8	73
Groin and lower extremities - - -	1,672	1,156	67·9	69
More than one bubo in different parts of the body.	114	75	4·6	66
Total - - -	2,465	1,731	100·0	70·2

(2.)—*Punjab.*
(*See* Evidence, 10,198.)

Situation of Bubo.	Number of		Percentage of	
	Cases.	Fatal Cases.	Cases to Total Bubonic Cases.	Case Mortality.
Head and neck	340	212	13·0	62·3
Axilla	343	218	13·1	63·2
Groin	1,735	957	66·6	55·4
More than one situation	139	86	5·3	61·8
Situations other than the neck, axilla, or groin	52	36	2·0	69·2
Total	2,609	1,215	100·0	46·5

(3.)—*Karachi.*
(*See* Evidence, 12,394.)

Situation of Bubo.	Number of		Percentage of	
	Cases.	Fatal Cases.	Cases to Total Bubonic Cases.	Case Mortality.
Neck	45	23	12·2	51
Axilla	60	34	16·3	56·6
Groin	245	131	66·6	53·5
Multiple	18	12	4·9	66·7
Total	368	200	100·0	54·3

Dr. N. H. Choksy, of the Arthur Road Hospital, Bombay (Bombay Medical and Physical Society, September 1900), analyses 9,500 cases of bubonic plague observed in the Plague Hospitals of Bombay City as follows:—

Situation of Bubo.	Percentage of Cases to Total Bubonic Cases Observed.	Case Mortality per cent.
Cervical	6·72	78·87
Parotid	1·68	70·34
Axillary	21·85	81·29
Femoral	30·87	72·56
Inguinal	23·25	77·62
Multiple	12·95	75·87
Other situations	1·68	71·42

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VIII.—RELATIVE FREQUENCY AND FATALITY OF BUBONIC PLAGUE AS INFLUENCED BY THE SITUATION OF THE BUBOES AND BY SEX AND AGE.

Karachi, 12,394.

Situation of Bubo.	Men.				Women.				Children.			
	Number of Cases				Number of Cases				Number of Cases			
	Observed.	Fatal.	Case Mortality per cent.	Per Cent. of Cases with Buboes in each situation to Total Cases observed in Men.	Observed.	Fatal.	Case Mortality per cent.	Per Cent. of Cases with Buboes in each situation to Total Cases observed in Women.	Observed.	Fatal.	Case Mortality per cent.	Per Cent. of Cases with Buboes in each situation to Total Cases observed in Children.
Neck	13	9	69	6·2	11	6	54·5	12·8	21	9	42·8	28·4
Axilla	29	17	59	14·0	15	10	66·6	17·4	16	12	75·0	21·6
Groin	156	81	52	75·0	57	26	45·7	66·3	32	19	59·4	43·3
Multiple	10	7	70	4·8	3	1	33·3	3·5	5	3	60	6·7
Total	208	114	55	—	86	43	50	—	74	43	58·1	—

IX.—FREQUENCY AND FATALITY OF PLAGUE WITH BUBONIC ENLARGEMENTS IN THE HEAD AND NECK.

(1.) *When the Buboes are single.*

Buboes.	Situation.			Percentage of Cases to Total Number (2,465) of Bubonic Cases observed.	Number of Fatal Cases.	Case Mortality.		
	Right.	Left.	Total.			Right. Per cent.	Left. Per cent.	Total.
Cervical - - -	67	29	96	3·89	69	68·6	79·3	71·8
Parotid - - -	12	20	32	1·30	20	58·3	65	62·5
Sub-maxillary - -	19	9	28	1·13	21	68·4	88·8	75
Occipital - -	—	—	2	·08	1	—	—	50
Total - -	—	—	158	6·41	111	—	—	70·2

(2.) *When there are more than one Bubo.*

Buboes.	Situation.			Percentage of Cases to Total Number (2,465) of Bubonic Cases observed.	Number of Fatal Cases.	Case Mortality.		
	Right.	Left.	Total.			Right. Per cent.	Left. Per cent.	Total.
Cervical + parotid - -	10	18	28	1·13	22	80	77·7	78·5
Double cervical + parotid -	—	—	5	·20	5	—	—	100
Cervical + parotid + sub-maxillary.	—	—	6	·24	4	—	—	66·6
Cervical + sub-maxillary -	—	—	12	·48	10	—	—	83·8
Double cervical - -	—	—	20	·81	19	—	—	95
Double parotid - -	—	—	11	·44	7	—	—	63·6
Total - -	—	—	82	3·33	67	—	—	81·7

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X.—FREQUENCY AND FATALITY OF PLAGUE WITH BUBONIC ENLARGEMENTS IN THE AXILLA AND UPPER EXTREMITIES.

(1.) *When the Buboes are single.*

Buboes.	Situation.			Percentage of Cases to Total Number (2,465) of Bubonic Cases observed.	Number of Fatal Cases.	Case Mortality.		
	Right.	Left.	Total.			Right. Per cent.	Left. Per cent.	Total.
Axillary - - - - -	240	162	402	16·31	298	72·5	76·5	74·1
Pectoral - - - -	5	4	9	·36	6	60	75	66·6
Supra Trochlear - - -	4	3	7	·28	4	50	66·6	57·1
Total - -	—	—	418	16·96	308	—	—	73·7

(2.) *When there are more than one Bubo.*

Buboes.	Situation.			Percentage of Cases to Total Number (2,465) of Bubonic Cases observed.	Number of Fatal Cases.	Case Mortality.		
	Right.	Left.	Total.			Right. Per cent.	Left. Per cent.	Total.
Double Axillary - -	—	—	5	·20	4	—	—	80
Axillary + Supra Trochlear + Brachial.	8	8	16	·65	10	50	75	62·5
Total - -	—	—	21	·85	14	—	—	66·6

XI.—FREQUENCY AND FATALITY OF PLAGUE WITH BUBONIC ENLARGEMENTS IN THE GROIN AND LOWER EXTREMITIES.

(1.) *When the Buboes are single.*

Buboes.	Situation.			Percentage of Cases to Total Number (2,465) of Bubonic Cases observed.	Number of Fatal Cases.	Case Mortality.		
	Right.	Left.	Total.			Right. Per cent.	Left. Per cent.	Total.
Femoral - - - -	365	310	675	27·40	429	64·3	62·5	63·5
Inguinal - -	180	180	360	14·60	246	69·4	67·2	68·3
Iliac - - -	4	7	11	·44	9	75	85·7	81·8
Popliteal - -	4	4	8	·32	4	50	50	50
Total -	—	—	1,054	42·76	688	—	—	65·3

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(2.) *When there are more than one Bubo.*

Buboes.	Situation.			Percentage of Cases to Total Number (2,465) of Bubonic Cases observed.	Number of Fatal Cases.	Case Mortality.		
	Right.	Left.	Total.			Right. Per cent.	Left. Per cent.	Total.
Femoral + inguinal - -	137	191	328	13·31	250	74·4	77·4	76·2
Femoral + inguinal + iliac	77	44	121	4·92	91	72·8	79·5	75·2
Femoral + iliac - -	33	29	62	2·52	47	75·7	75·8	75·8
Inguiral + iliac - -	40	33	73	2·96	57	79·5	78·7	78·0
Double femoral + inguinal -	—	—	12	·48	7	—	—	58·3
Double femoral - -	—	—	9	·36	7	—	—	77·7
Double inguinal - -	—	—	7	·28	7	—	—	100
Double femoral + double iliac.	—	—	4	·16	1	—	—	25
Double iliac - - -	—	—	2	·08	1	—	—	50
Total - -	—	—	618	25·07	468	—	—	75·7

XII.—FREQUENCY AND FATALITY OF PLAGUE WITH SEVERAL BUBOES IN DIFFERENT SITUATIONS.

Buboes.	Number.	Per Cent. of Cases to Total Number (2,465) of Bubonic Cases observed.	Number of Fatal Cases.	Case Mortality per cent.
Femoral + axillary + inguinal - - -	24	·98	13	54·1
Femoral + cervical + parotid - - -	15	·60	12	80
Femoral + iliac + cervical - - -	13	·53	8	61·5
Femoral + axillary - - - - -	11	·44	6	54·5
Axillary + parotid - - - -	8	·32	7	87·5
Femoral + parotid - - - - -	7	·28	5	71·4
Femoral (right) + inguinal (left) - -	6	·24	5	82·6
Femoral + iliac + parotid - - - -	6	·24	4	66·6
Cervical + sub-inguinal - - - -	4	·16	4	100
Axillary + parotid + double supra trochlear -	4	·16	3	75
Femoral + inguinal + cervical - - -	4	·16	2	50
Axillary + inguinal - - - -	4	·16		50
Femoral + inguinal + cervical + axillary + brachial.	3	·13	2	66·6
Femoral + inguinal + axillary + supra trochlear	2	.08	1	50
Double parotid + supra trochlear - - -	2	·08	1	50
Inguinal + cervical - - - -	1	·04	0	0
Total - - -	114	4·62	75	65·8

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APPENDIX No. II.

DESCRIPTION OF THE CLINICAL FEATURES OF PLAGUE BY THE PRESIDENT.

I.—INTRODUCTORY.

1. The present epidemic of plague in India has been characterised not only by a high mortality, but also by a great diversity in the symptoms of individual cases; and in both respects it has reproduced the most conspicuous features of the numerous epidemics of this disease which from a remote period have devastated extensive districts of Asia, Africa and Europe, under the names of the Black Disease, Black Death, Pest, Septic Pest, Plague, and Oriental, Levantine or Egyptian Plague. In these and in all other important respects it has also exhibited a close resemblance to the previous epidemics of plague in India, regarding whose characteristics details are in existence, such as the epidemics of Cutch, Gujarat, Sind, Kathiawar, Marwar, Kumaun and Garhwal.

Thesis on the Nature and History of Plague as observed in the North Western Provinces of India, by Frederick Forbes, M.D., 1840; Transactions of the Medical and Physical Society of Bombay, Vols. 1 and 2, 1838, 1839, Papers by Whyte, McAdam, Gilder and Forbes

II.—CLINICAL VARIETIES OR TYPES OF PLAGUE.

2. The diversity in the symptoms has led to numerous types or groups being recognised, mainly on the bases of (a) the severity of the symptoms, and (b) the prominence of one or several of them. Either basis might well be adopted for purposes of classification, but having regard to the present state of knowledge of the essential or real cause of the disease, which indicates its oneness under whatever symptomatic modifications it appears, the simplest subdivision would probably be obtained by adopting the basis of the severity of the illness. From this, however, an exception may conveniently be made in the case of prominent and early existing lung inflammation, as this represents a type having special interest in regard to the infectiveness of plague as well as to the application of measures for controlling its extension. At the same time, it is to be recognised that as plague produces pneumonia by the same virus or toxin as causes all its other manifestations, inflammation of the lungs may and does often occur, though to less extent, in other types of plague, and the above or any other subdivision of the disease is to be justified only on the grounds of convenience.

Adopting, therefore, as a fundamental basis of classification that of the degree of severity of the disease, and giving effect in this classification to the most formidable and conspicuous of the variations in its manifestations, the following types may for convenience be recognised, viz.:—

1. *Pestis minor*, the mild or phantom plague, including the abortive, atypical and so-called ambulatory forms.
2. *Pestis major*.—The disease presented in its most usual full development, the standard type, having many general and local symptoms, and especially glandular enlargements, elevation of temperature and great prostration; always a virulent affection, and occasionally so much so that death is caused before all of the usual manifestations of the type have had an opportunity of being produced, as in the so-called Septicæmic plague or Pesticæmia.
3. *Pestis pneumonica*, resembling in many respects the more severe form of the second group, but especially characterised by the early appearance of inflammation of the lungs.

In India, *Pestis minor* and *major* are often grouped together as Bubonic plague, and Septicæmic and Pneumonic plague considered as a second and third group, respectively.

3. *Pestis minor*.—In this the mildest type of plague, the patient suffers from headache and sleeplessness, from slight pyrexia, lasting only a few hours, from tenderness and pain over one or more superficial glands, usually those in the groin, which are 20,556. frequently enlarged, and occasionally also from nausea and vomiting. The duration may be as brief as only two or three days, but not infrequently the enlargement of the glands is more persistent, and the duration on this account, or because suppuration has taken place in the glands, is protracted to 10, 20, or even 30 days. All cases terminate in recovery. The patient is rarely confined to bed, and if so, only for a 10,365-8; 18,040; 22,349. day or two, and the general disturbance of health is often so unimportant that not only can the patient go about, but even ordinary avocations are not interrupted. As

7638–44; 24,117–9; 27,143–5; 26,989; 10,098–103; Inglis' Report, p. 13.

Captain T. E. Dyson, I.M.S., Couchman's Account of Plague Administration in the Bombay Presidency, p. 244; Captain C. H. James, I.M.S., Report on the Outbreak of Plague in the Jullundur and Hoshiarpur Districts of the Punjab, 1897–8, pp. 3, 4, 10; 10,334; 14,667; 15,226; 24,117; Choksy's Report on Plague, p. 16.

patients suffering from this type of plague rarely place themselves under medical treatment, there are few facts bearing upon its infectivity, but the endemic or epidemic character of *Pestis minor* and the progressive increase of cases, as well as the fact that the bacillus of plague has been found in the buboes and in pus and other discharges from them, leaves little room to doubt that it is capable of propagation from infected persons or things. Cases occur not only during the prevalence of virulent forms of plague, but also before these forms have become general, and during the decline or at the end of outbreaks. While, therefore, cases of *Pestis minor* are of relatively little importance to the affected persons, they are of great significance in the application of plague measures. Their occurrence in the absence of an epidemic of virulent plague may be the prelude to an ordinary epidemic, while their occurrence at the termination of such an epidemic may serve as an indication of the danger of recrudescence.

24,117. Gatacre's Report, p. 137; James' Report, p. 10; 10,335; Report on Bubonic Plague, by N. H. Choksy, p. 16. 18,064–5. 21,951–7; 21,967–74.

It is probable that *Pestis minor* may also occur without pyrexia, for cases have been observed in which buboes and slight general plague symptoms were present without any evidence of a rise of temperature. Further, the existence of a curious group of symptoms, which probably represents a variety of *Pestis minor*, has been brought before our notice by Colonel Fawcett and Captain Morgan, R.A.M.C. The symptoms were observed by them among Europeans engaged in plague work, who, about half an hour after handling plague patients, suffered from painful tingling and numbness in the hands, which extended to the lymph glands of the axilla, neck or groin, the glands becoming extremely painful, but being neither swollen nor tender. The pains generally disappeared in a few hours. In persons exposed at long intervals to plague infection the attacks were apt to recur, but they failed to do so in persons continuously engaged in plague operations. It may be noted that both of these probable varieties of *Pestis minor* were illustrated in Members of the Commission during their visit to India.

12,897 20,684–5.

12,398.

4. *Pestis major*.—In this form of plague the typical symptoms are sometimes produced so quickly that no premonitory symptoms are observed. In most cases, however, a prodromal or preliminary stage may be distinguished of several hours' duration. In this stage, the first indications of illness may be bilious vomiting and bilious diarrhœa. More frequently, the patient suffers from headache, which is usually frontal; sleeplessness, giddiness, and palpitation are often experienced; nausea and vomiting may be present; and there are pains in the limbs, lethargy and weakness. The gait may be unsteady and even staggering. The patient is either unable or indisposed to reply to questions. The mental processes are slow, and the appearance is suggestive of mild drunkenness. After these symptoms have continued for a few hours, rarely for so long as 24 hours, and while several of them are still present, one or more rigors, usually severe and prolonged, occur, and on examination it is found that a febrile temperature has been developed, that the pulse and respirations are rapid, that the skin is hot and dry, and that a bubo or buboes are present, which are painful and tender. The time of the first appearance of the buboes is either early and concurrently with the first symptoms, or from the second to the fourth day and rarely so late as the eighth day. The patient now lies in an apathetic and listless condition, with the face flushed, the eyes half closed, congested, yellow and sunk, and the pupils either dilated or in their normal state, unless contraction has been produced by conjunctivitis or by inflammation of deeper structures in the eyeball. The posture is distinctive of prostration and helplessness, and, usually, the patient lies on the back with the legs extended, and frequently with one of them crossed over the other, unless flexion at the hip has been caused by an exceptionally tense infiltration at the groin. Occasionally, however, the patient lies flaccid on one side, with both legs flexed and drawn up towards the abdomen, and the head bent forwards and downwards; but the posture is often varied by the mental condition of the patient and the accident of the position in which he has been placed by the attendants. Occasionally there is delirium, and the appearance of tiredness and apathy is replaced by that of great anxiety and even of terror. Sleeplessness, varied in some patients by a condition of drowsiness, is present; the speech is husky, slow, and even syllabic; but in a few instances questions were answered in an irritable and angry tone, as if the patient were annoyed at being disturbed. In a considerable number of cases, the power of articulation becomes further weakened and even aphonia is produced. The tongue is dry with red tips and edges, and with the dorsum covered, at the earlier stages, with a grey fur, which later is yellowish brown, and even black. The bowels are generally constipated, there is thirst, and usually the appetite is moderately good. A slight but offensive and distinctive odour may be perceived, independent of suppuration, and especially marked

Proceedings, Vol. I., Appendix VIII., p. 352.

20,666–7.

12,897.

579.

12,897.

7046; 12,897; Gatacre's Report, p. 58.

in severe cases. In a considerable number of cases the urine throughout the acute stages of the illness contains albumen in small quantity, as well as hyaline and epithelial tube-casts. Should the course of the illness be a favourable one, in from two to five days the temperature gradually falls, the skin becomes soft and moist, tenderness and pain depart from the buboes and they diminish in size, the pulse becomes slower and stronger, and the patient acquires a brighter aspect; but complete restoration to health is usually tardy and may be deferred until many months after the acute symptoms have disappeared.

When, however, as generally happens, the termination is not by recovery, death may be caused by sudden failure of the heart's action, or more rarely, during a protracted illness by a general weakness, often due to long continued suppuration of one or more buboes.

20,925.

This, which represents the usual or standard symptomatology of *Pestis major*, is frequently modified in two great respects: firstly, by the occurrence of symptoms not mentioned in the above description, and secondly, by variations in the severity of the illness.

In the present series of outbreaks in India, the added symptoms and the differences in their intensity have apparently produced all of the varieties of plague reported in the several epidemics which have occurred in other countries from the earliest epochs to the present time. For the symptoms of *Pestis major* have been modified sometimes so conspicuously as to suggest, as in the case of epidemics elsewhere, numerous further subdivisions of plague, by the occurrence of bowel complaints, ranging from simple to dysenteric diarrhœa; by prominent broncho-pneumonic complications; by skin affections, varying from vesicular and pustular eruptions to necrosis of the skin; by cellulitis and gangrene; by eye affections, implicating not only the superficial but also the deeper structures, and occasionally leading to loss or permanent impairment of visual power; by lymphangitis; by hæmorrhages in the skin and from the stomach, bowels, lungs, or kidneys; and by symptoms referable to the nervous system, such as peripheral neuritis and irritative and paralytic lesions of the nerve-centres, leading to convulsions, hemiplegia, paraplegia, coma or insanity.

16,818; Choksy's Report on Bubonic Plague, p. 37.

As to the modifications produced by the variations in the severity of the symptoms, the evidence placed before us has rendered it clear that these symptoms may not only be more restricted and less severe than in the standard type, but also that they may be more restricted and more severe. Cases have occurred which, on the one hand, as it were, together constitute ascending series from mild forms of *Pestis minor* to standard forms of *Pestis major*, and, on the other hand, which much transcend in severity the average or standard type of the disease. In illustration of the former modification, reference may be made to the occurrence, at all stages of outbreaks, of cases which though relatively mild were so in different degrees, and to the occurrence of outbreaks with a large proportion of non-fatal cases.

5. *Pestis Septicæmica.*—Cases transcending in severity the average type of *Pestis major* are exemplified in the numerous instances in which patients have exhibited one or several of the additional symptoms which have been mentioned. They have, however, been more conspicuously apparent in a considerable number of severe cases in which, instead of increase, there has been restriction in the number of symptoms. In these cases, without any premonitory symptoms, rigors, pyrexia, vomiting, cardiac weakness, and great nervous and muscular prostration have quickly appeared, and life has frequently become extinct within a few hours, although in several instances death did not occur until the second, third, fourth, and even fifth day. Such cases are usually termed septicæmic, and those which end in death within a few hours have been further distinguished as fulminant or lightning plague, or *Pestis siderans*. The distinctive characters of Septicæmic plague are not, however, clearly defined. The absence of sufficient definition has been illustrated in tabular statements in which plague cases have been classified as Bubonic, Pneumonic and Septicæmic, and still a fourth class added of "neither Pneumonic nor Bubonic," in which the severity of the disease may nevertheless be so great as to produce a mortality of 90 per cent. Apart from certain features in its morbid anatomy, which by a few observers have been considered sufficient to establish it as a separate variety, the term has most frequently been applied to all cases other than pneumonic where the symptoms were of exceptional severity. In some of the described cases, external buboes, similar to those of *Pestis major*, were present; in others there were no buboes; but in all cases, the lymphatic glands were involved, even although no external buboes were present. The history of the cases of so-called Septicæmic plague suggests a distribution throughout the body

Proceedings, Vol. I., Appendix XIV., p. 381.

R. N. Jadhav's Report, p. 14.

Proceedings, Vol. I., Appendix XIII., p. 368; 26,585.

of virulent plague virus, more rapidly effected than in the cases representing the standard type of *Pestis major.*

Proceedings, Vol. I., Appendix XIII., p. 375.

6. *Pestis Pneumonica : Primary Pneumonic Plague.*—The pneumonic form of plague is of great interest in reference to the extension of plague and the efficacy of the measures for its control. Although well known in many previous epidemics of plague, it appears to have been first recognised in the present Indian epidemic by Captain Childe, I.M.S., who found that coincidently with the increased death rate from plague in Bombay there remained a large and unsatisfactorily explained increase, which had been assigned to remittent fever and diseases of the respiratory organs. Further investigations showed that many of these cases were actually cases of plague, in which the disease manifested itself chiefly by lobular inflammation of one or both lungs, and in which the true nature of the affection was demonstrated by the discovery of plague bacilli in the sputum.

Gatacre's Report, p. 98.

Proceedings, Vol. I., Appendix XIV., p. 381.

12,915; 13,104; 15,173; 18,204; Proceedings, Vol. I., Appendix VIII., p. 352.

It has now been established that in a considerable number of cases of plague the chief manifestation of the affection is inflammation of the bronchi and of the lobules of the lung, and that in the majority of these cases one of the most significant of the plague symptoms, viz., inflammatory swelling of the external lymph glands, is generally absent. The pneumonic type of plague is characterised by an abrupt development of symptoms, and especially of symptoms indicative of inflammation of the lungs. Early in the disease, the respirations become rapid and laboured; cough, frequently with slight pain in the chest, is present; and the sputum, though occasionally scanty, is generally abundant, frothy and watery, and coloured with blood either in red specks and streaks, or uniformly with a rosy but not rusty appearance. The sputum, therefore, rarely possesses the special characteristics of croupous pneumonia. Physical examination generally shows circumscribed areas of consolidation in detached portions of one or both lungs, but in some cases the consolidation is stated to have involved an entire lobe or even the whole of one lung; and rhonchi and fine and medium crepitations are audible on auscultation. Nearly all of the patients died within a few hours of the commencement of the illness, and but few survived until after the second or third day. In the latter event, the involvement of the lymphatic system, which is so characteristic of plague, has occasionally been made manifest before death by the appearance of gland-swellings in the neck or axilla, or in the sub-clavicular or upper mammary region, or even in the groin. As pneumonic plague has generally been most prevalent during the middle of outbreaks, it may sometimes become an important element in causing the high mortality which occurs at those times.

Proceedings, Vol. I., Appendix XX., p. 471. 13,594–7; 15,282–4; 17,988. 1517; 15,280; 17,990–1; 18,214; 18,253.

7. *Relationship to each other of the several Types of Plague.*—The intimate relationship which exists between these types of plague is shown by the circumstances that the standard bubonic type, or *Pestis major*, may pass into the Septicæmic, and in the greatest number of fatal cases actually does so; that inflammation of the lungs not only occurs so conspicuously and early in plague as to become the fundamental condition of the pneumonic type, but also constitutes one of the most frequent of the complications of *Pestis major;* and that any one type does not reproduce itself only, but also other types, as when the bubonic produces septicæmic and pneumonic, when the septicæmic produces bubonic and pneumonic, and when the pneumonic produces bubonic and septicæmic cases.

It may also be stated that the occasional predominance of others of the pathogenic effects of the plague virus has led to further subdivisions of the disease, such as the nervous, the abdominal, the gastro-enteric, and the dysenteric.

8. *Relative Frequency of Occurrence of the several Types.*—Of these several types or varieties of plague, *Pestis major* occurred with much the greatest frequency; but differing statements have been laid before us as to the relative frequency of each type.

Campbell's Report of the Bombay Plague Committee, 1898, p. 138; 9539–40. 7073; Report on Working of the Diliawadi Plague Hospital, 1898, p. 14. 3483. Campbell's Report, p. 151. 6861.

In the conjoined cases of Colonel Hutchison and Captain Elphick, I.M.S., amounting to 969 in number, 77·5 per cent. were cases of *Pestis major*, 11·6 per cent. of *Pestis pneumonica*, and 8·7 per cent. of *Pestis septicæmica;* and in the statistics of Lieut.-Colonel Harris, I.M.S., and of Mr. R. N. Jadhav, L.M. and S., pneumonic cases also slightly preponderate over septicæmic. On the other hand, Colonel Benson, I.M.S., out of a total of 1,963 cases, estimates that the cases of *Pestis major* represented 47·1 per cent., of *Pestis pneumonica* only 1·6 per cent., and of *Pestis septicæmica* so many as 34·9 per cent.; in 417 cases tabulated by Mr. Bhatt, L.M. and S., 84·41 per cent. were cases of *Pestis major*, 6·7 per cent. were cases of *Pestis pneumonica*, and 7·43 per cent. were cases of *Pestis septicæmica;* and in 98 cases tabulated by Major Evans, I.M.S., the relative frequency of each type was 65·3 per cent., 14·2 per cent., and 20·4 per cent., respectively.

In a few local outbreaks, the recognised pneumonic cases were even in a smaller minority than in any of the above instances. For example, Mr. Maynard, M.R.C.S., stated that in Nasik, between February 1897 and April 1898, there were only five cases, although the deaths from plague numbered 486, representing a case incidence of considerably less than 1 per cent of pneumonic cases; 14,709, 14,731. and in Mr. Madhava Rao's classification of 2,053 cases in the Bangalore outbreak of 1898–9, only 1·4 per cent. were cases of pneumonic, whereas 38·5 per cent. were cases of septicæmic plague, the remainder comprising 58·7 per cent. of bubonic and ·2 per cent. of gastro-enteric cases. On the other hand, in one or two outbreaks, most and even all of the cases were pneumonic. Report on Plague Operations in the Mysore State, 1898–9, p. 8. 7337–44.

In the case of Septicæmic plague, the numerical variations are no doubt chiefly to be explained by the absence of any sufficient symptomological definition of the type, but they may also be explained by its unequal prevalence in different localities and at different times; 15,182. and these latter circumstances, along with the delay in its recognition at the earlier periods of outbreaks, probably account for the similar variations in the statements regarding the prevalence of Pneumonic plague.

III. Brief Account of the Principal Symptoms.

9. *Buboes and Lymphatic System.*—Implication of the external lymphatic glands is so frequent and conspicuous a condition of plague that it becomes one of the leading symptoms, and has suggested its most recent, though insufficiently comprehensive, name, Bubonic plague. Enlargement of these glands is one of the earliest of the symptoms, and frequently coincides with the production of pyrexia, although it has occasionally been found even to precede the pyrexia. 10,203 In the majority of cases, buboes appear within six hours after the beginning of the illness, but their appearance may be delayed for several, occasionally for three or four, days, and in one recorded instance the interval has been so long as eight days. Campbell's Report, p. 124; 20,708; 12,897. Before enlargement can be discovered, there is often pain and tenderness at the position where it subsequently appears. The glandular swelling is usually painful and tender, the pain being either dull or sharp and lancinating; Dyson and Calvert's Report, p. 3. but in a few cases these characters were absent and small or large buboes could be freely handled without discomfort to the patient. 20,713–4. On its first appearance the bubo is most frequently small, varying in size from a pea to an almond, but growth is rapid, and in a few hours it may even attain the size of an orange. The increase to a large size is, however, most frequently produced by involvement of several neighbouring glands or by extension of inflammation to the contiguous tissues, which become infiltrated with serous or sero-sanguineous effusion, R. N. Jadhav's Report on Daliawada Plague Hospital, p. 19; N. H. Choksy's Report on Plague p. 22. or even with pure blood. The latter was found to occur most frequently in association with cervical and axillary buboes. This infiltration varied much in extent and rapidity of production, and when it occurred in association with axillary or pectoral buboes, it was sometimes observed to increase rapidly, so as to involve the whole of the side of the chest, and to extend to the cervical region and even to the vertebral column. Campbell's Report p. 135; R. N. Jadhav's Report, p.19; Proceedings. Vol. I., Appendix VIII., p. 351. Its extent and position had also an important influence upon the progress of the case, for a large infiltration in the cervical or in the axillary region nearly invariably produced death, whereas a similar or even greater infiltration in the femoral region merely prolonged convalescence, and did not in itself endanger life. Choksy's Report on Bubonic Plague, p. 23. Campbell's Report, p. 135; Snow's Report, p. 232 Lloyd Jones' Report on the Plague Hospital, Poona, p. 8. Report on Bubonic Plague, p. 42.

According to Dr. Choksy, the distribution of the buboes in 939 cases of plague admitted into the Arthur Road Municipal Hospital, Bombay, was as follows:—

Femoral	275 cases
Femoro-inguinal	200 ,,
Axillary	140 ,,
Inguinal	106 ,,
Cervical	45 ,,
Multiple	40 ,,
Femoral-inguinal and iliac	17 ,,
Femoral and iliac	12 ,,
Inguinal and iliac	11 ,,
Double femoral	3 ,,
Supratrochlear	3 ,,
Iliac	2 ,,
Double inguinal	1 case
Double cervical	1 ,,
No buboes	83 cases

It appears from this table that the femoral buboes were the most frequently encountered, and after them the femoro-inguinal, and thus groin buboes were shown greatly to preponderate in number. In only 8·5 per cent. of the total cases were there no buboes. If the percentage of each of the first six classes to the total be calculated, representing about 94 per cent. of the buboes in the 939 cases, this preponderance of groin buboes is represented by 67·86 per cent.; the axillary buboes being 16·35 per cent., the cervical 5·25 per cent., and the multiple buboes 4·67 per cent.

Proceedings, Vol. III., Appendix LXI., p. 458. 10,198.

This order in the frequency of buboes in the chief situations in which they occur seems to be generally maintained in the other statements laid before us, but the details of the relative numbers vary considerably. For example, in 3,128 cases which occurred in the Jullundur and Hoshiarpur outbreak of 1897–98, 54·46 per cent. had groin buboes, 10·96 per cent. had axillary buboes, 10·86 per cent. had cervical buboes, and 4·44 per cent. had multiple buboes; while of the remainder, 16·62 per cent. had no buboes. Again, in 2,815 cases having groin, axillary and cervical buboes, collected by Captain Jennings, I.M.S. and Captain Lloyd Jones, I.M.S., 1,947, or 69·1 per cent., were groin buboes, 598, or 21·2 per cent. were axillary buboes, and 270, or 9·59 per cent., were cervical buboes; showing a much greater preponderance than in the Jullundur and Hoshiarpur statistics of axillary over cervical buboes.

Campbell's Report, p. 115; Report on the General Plague Hospital, Poona, p. 18.

Buboes have sometimes been found to occur in other situations than those noted above, as in the popliteal, brachial, and sub-maxillary regions, the forearm, calf of the leg, elbow, knee, chin, and scalp, and in the supra-trochlear, parotid and mammary glands. They have, however, only rarely been found in these situations. In the Jullundur and Hoshiarpur outbreak, buboes in such exceptional positions altogether amounted to only 1·66 per cent. in the 3,128 cases.

Gatacre's Report, p. 49.

10,198.

10. *Distribution of Buboes according to Locality and Sex.*—Buboes appear to occur more frequently on the right than on the left side. In 4,332 cases with buboes, representing plague cases in Bombay, Poona and Porbandar, 51·62 per cent. were on the right and 48·33 per cent. on the left side; but while the majority of the buboes (56·3 per cent.) were on the right side in the Bombay cases, the majority (50·54 per cent.) were on the left side in the Poona cases. In the total 4,332 cases, the greater general frequency of buboes on the right side was maintained in the three chief localities in which they occur, as 1,462, or 51·5 per cent., of the groin buboes, were on the right side, and 1,376, or 48·48 per cent., on the left side; 493, or 50·8 per cent., of the axillary buboes were on the right side, and 477, or 49·17 per cent., on the left side; and 276, or 52·67 per cent., of the cervical buboes were on the right side, and 248, or 47·3 per cent., on the left side.

Proceedings, Vol. II., Appendix XLIX., p. 423 (1); Lloyd Jones' Poona Report, p. 18; Campbell's Report, pp. 115 and 138; Gatacre's Report, p. 49.

In reference to the distribution in the two sexes, in 3,909 of the above 4,332 cases, in which the number of groin, axillary and cervical buboes is separately noted in the two sexes, 1,529, or 58·73 per cent., of the 2,603 groin buboes occurred in men, and 1,074, or 41·26 per cent. in women; 475, or 51·63 per cent., of the 920 axillary buboes occurred in men, and 445, or 48·37 per cent., in women; and 219, or 56·73 per cent., of the 386 cervical buboes occurred in men, and 167, or 43·26 per cent., in women.

Estimating, in men and women separately, the numbers in each group of these 3,909 cases, it is found that of 2,223 buboes in men, 1,529 or 68·79 per cent. were groin buboes, 475 or 21·36 per cent. were axillary buboes, and 219 or 9·85 per cent. were cervical buboes; and that of 1,686 buboes in women, 1,074 or 63·7 per cent. were groin buboes, 445 or 26·4 per cent. were axillary buboes, and 167 or 9·9 per cent. were cervical buboes. It would appear from the last estimation, that, relatively to other buboes, axillary buboes are more frequent in women than in men, that groin buboes are relatively more frequent in men than in women, and that cervical buboes, relatively to other buboes, occur about as frequently in men as in women.

When the side of the body on which each set of the 3,909 buboes occurred in the two sexes is determined, it is of interest to find that while groin and cervical buboes occurred in both sexes more frequently on the right than on the left side, axillary buboes, although also more frequent on the right side in men, were, contrary to the statement of several observers, actually more frequent on the left than on the right side in women, in the ratio of 233 to 212, or 52·36 to 47·64 per cent. In men, the ratio was 242, or 50·94 per cent., on the right, and 233, or 49·05 per cent., on the left side, giving almost an equality between the two sides.

This preponderance of axillary buboes on the left side in women is also separately illustrated in several of the tabular statements submitted to us, as in that of Surgeon-Captain Lloyd Jones, representing 1,122 cases of plague, of Dr. L. T. R. Hutchinson, representing 854 cases, and of Mr. H. S. Deva, representing 274 cases.

Report on the General Plague Hospital, Poona, p. 18; Campbell's Report, pp. 137-8; Proceedings, Vol. I., Appendix XLIX., p. 485.

The glandular enlargements, however, are not restricted to the superficial glands, for deeply-seated glands, such as the mediastinal, bronchial, mesenteric, iliac and pelvic, may likewise be affected; and it has not infrequently been found that the iliac and pelvic glands are enlarged in association with superficial glands at the groin, so as to form with them a continuous bubo.

Proceedings, Vol. I., Appendix XIII., pp. 368, 371.

Nor does the mere production of these enlargements represent the extent of involvement of the lymphatic system. Lymphangitis has occasionally been observed, which involves both the superficial and deep vessels. It most frequently affects the lower extremities, sometimes causing swelling of the entire limb from the groin to the foot, and when it occurs the prognosis of the case is rendered specially grave.

20,491, 20,497–8; Gatacre's Report, p. 67; 20,662–3.

Buboes may gradually undergo resolution, or they may suppurate. In the former case, they may disappear in from a week to a fortnight; in the latter case, progress is usually very slow, sloughing may occur, and a large open sore may be formed, exposing muscles and blood vessels and weakening the patient by profuse discharge. Death is in this manner occasionally produced long after the immediate dangers of plague have disappeared.

9566.

Snow's Report, pp. 233, 234; 20,739–42.

11. *Temperature.*—Elevation of temperature is an early and constant symptom, and sometimes in a few hours after the initial rigor the temperature reaches so high an elevation as 103° or 104° F. More frequently, however, the rise is a less rapid one on the first day, and it gradually continues until the maximum is reached on the second, third, or fourth day. The pyrexia is of a remittent type, a morning decline being succeeded by an evening elevation of one or two degrees. The usual range appears to be between 102° and 105°, and the lowest and highest temperatures recorded in *Pestis major* have been 100° and 110° respectively, and the highest temperature in pneumonic plague, 110·8°. The degree of elevation is not in itself an indication of the severity of the illness, for in several fatal cases it has not exceeded 103°, while in cases which have recovered it has attained so high an elevation as 106·4°. The usual course in favourable cases appears to be that after the maximum temperature has been attained, it continues, with remissions, until the fifth, sixth, or seventh day, and then falls gradually and irregularly, by lysis, to the normal temperature on or about the tenth day. Frequently this gradual fall is of a "staircase" character. An abrupt fall, by crisis, of from four to six degrees, or to any point below the normal, almost invariably indicates collapse and speedy death. Prolonged elevation of temperature was usually associated with a suppurating bubo, and sudden elevation after or before the normal point had been reached with the formation of new buboes or with the advent of some complication, such as broncho-pneumonia, lymphangitis, abscesses, boils, or septic poisoning. In a few cases, recrudescence of the illness during convalescence has, accordingly, been observed, in which fresh buboes have appeared along with pyrexia and other of the usual symptoms of plague.

Proceedings, Vol. III., Appendix LXIII.

Gatacre's Report, pp. 56–57; 20,687.

1861; 12,897.

Gatacre's Report, p. 98; 20,695; 26,595.

20,691.

Choksy's Report on Bubonic Plague, p. 21.

12,897; 20,698. *See* Charts, Proceedings, Vol. I., pp. 385–9.

Snow's Report, p. 229; 20,699.

Choksy's Report on Bubonic Plague, p. 22.

12. *Circulation.*—In a few cases, slight precordial pain and palpitation were complained of, but generally there were no symptoms of disorder of the circulation which attracted the notice of the patient. Nevertheless, almost without exception, the circulation is early and profoundly affected. At the commencement of the illness the pulse rate acquires an exaggerated frequency, so that it is found to be at the rate of from 110 to 120 in the minute, and in the course of the illness it may even attain a rate of 140 or 170; while the normal relation of its frequency to the respiration and temperature is disordered with an irregularity which is observed in few diseases. It is, however, more from the characters of the pulse than from its rapidity that indications are obtained of the great changes in the circulation which occur in plague. When examined early in the illness, it is found to be in some cases of considerable and in others of small volume; but even in the former event, the ease with which the pulse may be obliterated proves it to be very feeble. It soon becomes also intermittent or otherwise irregular, dicrotic and very small, and, ultimately, even in cases which recover, it may no longer be countable, and its rate can be ascertained only by palpation or auscultation of the heart. This weakness of the circulation explains the frequently observed state of coldness of the extremities while yet the thermometer records in the axilla or mouth a temperature of pyrexia. It is also accountable for the numerous cases of sudden death which have taken place when the patient, often apparently in no critical condition, changes his posture from a recumbent to a sitting one, or even when, while still recumbent, he makes some slight physical exertion. A much larger number of the plague deaths for which it is accountable are, however, produced by progressive weakness of the circulation to a point at which life can no longer be maintained.

20,800.

Proceedings, Vol. III., p. 529.

12,897.

20,407.

20,800.

A Report on Plague by Surgeon Captain James, 1897, p. 7; 20,915.

Gatacre's Report, p. 59.

As the heart sounds are stated to be generally normal and the impact fairly strong at the same time as the pulse is very feeble, much of this early induced extreme weakness of the circulation is probably to be explained by vaso-motor paralysis. Several of the *post-mortem* appearances are in harmony with this explanation, but the experimental demonstration of vaso-motor paralysis by plague toxin has not yet been obtained.

20,803; Choksy's Report, p. 32.

13. *Blood.*—Apart from bacteriological examination of the blood, but little has yet been done to ascertain its condition during plague. It would seem that it retains its normal appearance and coagulability, and that the red cells are not reduced in number to any important extent, but that the number of leucocytes is considerably augmented.

20,823.

14. *Respiratory System.*—Even in cases in which there are as yet no lung complications, the respirations are from the beginning increased in frequency. This increase is at first only moderate, but frequently it becomes so great that the rate is 30 or 40 or even 60 in the minute. The latter, however, generally indicates the establishment of pulmonary congestion or œdema, both frequent complications of plague, and this œdema is a more frequent contributory cause of death than the secondary pneumonia or bronchitis occasionally produced. When pulmonary œdema is present the respirations are very frequent and laboured and the dyspnœa is intense. The sputum varies greatly, as, indeed, might be expected from the variations in the lung and bronchial conditions. It is, in some cases, scanty, bloodstained, and even viscous, and in others, abundant, watery and deeply coloured with blood; but actual hæmoptysis has been observed in relatively few cases.

12,398; 12,897; 20,831; Campbell's Report, p. 118.

15. *Digestive System.*—The condition of the tongue has by several witnesses been regarded as an important diagnostic condition, and therefore its appearance may be described with some detail. At first it is narrow and coated with a whitish, thin and silvery fur, confined to the dorsum, but increasing in depth towards the root, and most marked on each side of the raphe, while the tips and edges are red and usually moist. The fur becomes yellow, then brown and cracked; and it sometimes falls off in flakes, which expose a clean, raw, irritable-looking surface. At a later period in the more severe cases, it is also tremulous, protruded with difficulty, and dry, and in these cases sordes collect on the lips, teeth, and gums.

20,842.
20,844-9; 20,854.
Gatacre's Report, pp. 29-30; Campbell's Report, p. 130.
20,850.
Gatacre's Report, p. 66; 20,852-4; Jadhav's Report, p. 25.

The patient is generally thirsty, but the appetite is rarely impaired unless the case be an advanced one of severe type. Difficulty of swallowing was observed in a few cases, and in them was accounted for by enlargement of the neck glands and inflammation of the surrounding tissues. Hiccough, nausea, and vomiting are frequent symptoms and the vomited matter is usually bile-stained, but in several instances it has the appearance of coffee grounds, as if mixed with blood. Actual hæmatemesis was a rare event, although at certain periods of the epidemic, and especially when plague had assumed an especially virulent type, several deaths were caused by profuse hæmorrhage from the stomach. The bowels were usually in a state of constipation. Diarrhœa is therefore rarely present, and when, before convalescence, it followed constipation, it nearly invariably indicated an early fatal termination. Blood in the stools was but rarely seen and was always followed by death.

20,764.
Proceedings, Vol. I., Appendix VIII., p. 352.
10,422; Gatacre's Report, p. 66.
15,300-4.
20,855; Gatacre's Report, p. 98.
15,307.

16. *Genito-Urinary System.*—In all cases of *Pestis major*, the urine was diminished in quantity and was high-coloured. Retention was on the whole frequent, and it was stated that even suppression occurred in a few cases. The urea, uric acid, and chlorides were diminished. During the acute stage, albumen in small quantity was present in at least from 33 to 50 per cent. of the cases, but one observer with large experience asserts that it was present in all cases. Whenever albumen was present, hyaline and epithelial tube-casts were also found. Hæmaturia was a rare event. In non-fatal cases, the abnormal conditions of the urine quickly disappeared as convalescence became established.

20,861; Gatacre's Report, p. 66.
Proceedings, Vol. I. Appendix VIII., p. 352; 20,864; Gatacre's Report, pp. 66, 150.

In women at the period of menstruation, prolonged and profuse menorrhagia was frequently induced, and when amenorrhœa existed menstruation was re-established. Fatal abortion was nearly always caused in pregnancies which had advanced beyond the third month; and it is a remarkable fact that when the pregnancy was near the full time the infant might be born alive and free from symptoms of plague, while the mother almost invariably died.

Proceedings, Vol. I., Appendix XIV., p. 380.

17. *Nervous System.*—Involvement of the nervous system is indicated very early in the disease. Even in *Pestis minor* it may display itself by a peculiar desire, inexplicable and unaccountable to the patient, to remove from one place to another. In *Pestis*

major and in *Pestis pneumonica,* it early manifests itself by severe frontal headache, vertigo, irritability and sleeplessness, and by pains in many situations, such as the back of the head, over the spine, or in the course of the sciatic nerves. As the illness advances, there supervene in many cases tremors and lessened activity of the superficial reflexes. When the disease has fully developed itself, there follow bluntness of the mental power and delirium or coma of varying degrees. The delirium may even appear at the beginning of the illness. It may be acute or of a low muttering type. In its acute form, it may become maniacal, requiring restraint, or it may assume a homicidal character. As occurs in cases of *Pestis minor,* a desire to wander about sometimes manifests itself. In the mountainous districts of Kumaun and Garhwal patients have been known to fall or throw themselves down precipices, and at Banga a woman in a state of delirium threw herself into a well and was drowned. In many cases delusions and hallucinations were present. The patients would show by their movements that they were under the delusion that they were following their customary trades. Hallucinations were manifested by patients imagining that they saw before them relatives or friends when none were present, or that they heard sounds such as of the chopping of wood or the grinding of corn. In children, involvement of the central nervous system was frequently manifested by convulsive movements, general or restricted to certain groups of muscles; and convulsions also occurred in adults, but usually at an advanced period of the illness, and presenting every variety of general or localised spasms. They were often, indeed, so obviously of a tetanic character as to suggest the co-existence of intoxication by the tetanus bacillus. General convulsions in children, and symptoms indicating decided involvement of the central nervous system in adults, were generally followed by death.

Lieut.-Colonel Weir, I.M.S. Snow's Report, pp. 54, 61.

20,756.

26,587. James' Report, p. 32.

20,767-8.

Snow's Report, p. 237.

Campbell's Report, p. 160; 20,786.

Sensory hyperæsthesia was also frequently observed, during which the slightest touch would produce loud "screams, which not only pervaded the hospital, but even attracted the notice of passers by on the road." Several of the witnesses have described impairment of speech as a frequent symptom, and it is also referred to in many of the reports submitted to us. Impairment and even complete loss of speech have undoubtedly occurred as a result of defective power of articulation, due to general feebleness, or to paralysis of the laryngeal muscles, and probably also to congested swelling of the tongue, glottis, and laryngeal membrane. Besides impairment or loss of speech from aphonia and from greatly enfeebled mental power, it is possible that aphasia sometimes occurs as a symptom of plague, although the evidence on the subject is by no means clear.

20,778.

N. H. Choksy, Report on Bubonic Plague, p. 29.

12,400-2; 12,901-5.

Proceedings, Vol. Appendix XIV., p. 379.

579; 13,044-6; 21,031-2; 21,044; Choksy's Report, pp. 30-31.

18. *Skin and Subcutaneous Tissues.*—The extent and nature of the affections of the skin are of much interest, because of frequent references to skin eruptions in the descriptions of many of the epidemics of plagues that have occurred prior to the present epidemic in India.

20,678-82.

While petechiæ have been observed in a few cases, the descriptions of the symptoms of the present Indian epidemic indicate that they were either of relatively infrequent occurrence, or were so much obscured by the dark colour of the skin as to have generally escaped observation. At *post-mortem* examinations, however, they were more frequently observed. Thus, Captain Childe, I.M.S., remarks that they were usually seen on the limb on which the bubo was situated, and "were always in greatest number over the bubo itself; and though there might be some over the body generally, still these were but few." Purpura, also, was but rarely encountered, but in many advanced cases vesicles with hæmorrhagic contents were seen, and extravasations of blood in and around buboes were of frequent occurrence.

1419; 20,883; Gatacre's Report, pp. 98, 147; Snow's Report, p. 245; Proceedings, Vol. II., Appendix XXV., p. 359.

1419; Proceedings, Vol. I., Appendix XIII., p. 367.

Pustular eruptions showed themselves in the form of ordinary boils, and also of so-called "black boils." The latter were observed to originate in vesicles which gradually formed themselves into pustules containing also blood and serum, and which extended downwards into the skin, producing a slough. They varied from a half to one inch in diameter, and were situated on the limbs or trunk near to or in actual contact with the lymphatics of neighbouring buboes; and "inquiries often elicited the fact that the first sign of the plague was this skin manifestation followed by a bubo."

Gatacre's Report, p. 67; Snow's Report, p. 127; 4562.

A more definite primary plague vesicle or "phlyctenule" has occasionally been observed. Originating as a small papule, it quickly assumes a vesicular character, so that on the second day of the illness it is about one-fourth of an inch in diameter, pearly-grey, translucent and slightly umbilicated, covered by a thin epidermis and surrounded with a zone of inflammatory exudation. It gradually enlarges, the contents become turbid, and, from the fourth to the seventh day, it resembles a

From description by Dr. Turkhud, Bombay; 4562; 7302; 20,597-608; Proceedings, Vol. I., Appendix XIII., pp. 374-5.

vaccine pustule of seven days' duration. The epidermal covering then disappears and exposes a greyish-yellow slough, which may either dry up and scab, or form a suppurating and slowly-healing ulcer. As this vesicle is always accompanied with a bubo in the lymphatic gland nearest to the skin surface on which it is situated, and as it contains plague bacilli, the view is entertained that when it exists, it indicates the point of entrance of plague bacilli into the body and is produced by the introduced bacilli.

7302. Necrotic sloughs, situated usually on the loins, back, and intra- or supra-scapular regions, were also observed. They likewise originated from pustules which underwent transformations similar to those above mentioned, and ultimately produced scab-like necrotic sloughs covered with small vesicles, varying from 1 inch to 8 inches in diameter, which gradually encroached outwards and downwards until the underlying muscle became involved.

12,360–74. In a small number of advanced cases, gangrene occurred in the peripheral portions of the extremities. It usually started as a blister or a small abscess. The gangrene rapidly involved the neighbouring tissues, and extended also usually from the foot to the knee or from the hand to the elbow. The skin acquired the characteristic coldness and dark green colour, and became covered with large vesicles containing watery pus. In several cases, and even when much destruction of tissue had occurred, it was found that prompt treatment by subcutaneous injection of mercuric chloride was successful in checking the progress of the gangrene.

Snow's Report, p. 109; 27,166; 6,955; Proceedings, Vol. I., 376; 7073; Gatacre's Report, p. 58; Dyson and Calvert's Report, p. 3; 7302; Snow's Report, p. 244.

It may further be stated that carbuncle, of the ordinary surgical variety, has only occasionally been observed, the condition most closely resembling it being the localised necrosis terminating in slough, above described; and that boils and small abscesses frequently appear during convalescence and constitute troublesome sequelæ.

Snow's Report, p. 248; Gatacre's Report, p. 248; Jadhav's Report, p. 19; 20,577–80; 20,772–6. 16,818; 20,787–91; Proceedings, Vol. I., Appendix VIII., p. 352, and Appendix XIV., p. 380. 7261–9, Vol. III.; App. LXXXVII., p. 657; 18,018; 19,596; 19,355; 23,103–7; 23,710; Snow's Report, 171; 18,025; 19,623; 19,108.

19. *Complications and Sequelæ.*—Plague has occasionally been complicated by the concurrence of sub-acute rheumatism, arthritis, malaria, phthisis, cholera, erysipelas, dysentery, and relapsing (or famine) fever, as well as of bronchitis, catarrhal and croupous pneumonia, tetanus, and other affections which have previously been mentioned.

The most important of the sequelæ which have been observed were dysentery, anæmia, phthisis, and diseases of the nervous system, and included in the latter were peripheral neuritis, pareses and paralyses of various kinds, and mental impairment.

Plague appears to resemble other infectious diseases in so far that one attack occasionally fails to confer immunity against subsequent infections. Several cases have been submitted to us in which two and even three attacks have occurred in the same person, at intervals between each attack varying from eight days to two years and two months.

सत्यमेव जयते

IV.—PATHOLOGY.—MORBID ANATOMY.

Post-mortem Appearances.

Gatacre's Report, p. 73; Dr. James' Report on the Outbreak of Plague in the Jallundur and Hoshiarpur Districts of the Punjab, p. 147; R. N. Jadhav's Report, p. 35. Report on Bubonic Plague, 1897, pp. 54–7; 20,972; Proceedings, Vol. I., Appendix XIII., pp. 367–376, 1419; Report on Plague in Bombay, p. 6; Gatacre's Report, p. 74; Proceedings, Vol. I., Appendix XVII., p. 439; 10,418; 6912; 9552.

20. Caste and other prejudices of the natives, which were consistently respected, have limited the number of *post-mortem* examinations relatively to the large mortality from plague in India. Descriptions of the post-mortem appearances have, however, been laid before us, which together amount to a considerable total, and are sufficient to clearly establish the more important pathological features of plague. Reference may specially be made to the reports of Dr. Choksy, Captain Childe, I.M.S., Dr. Dyson and Captain Calvert, I.M.S., Captain Thomson, I.M.S., and Captain Leumann, I.M.S.; and to the evidence of several of these gentlemen and also of Captain Wilkinson, I.M.S., Major Evans, I.M.S., and Captain Elphick, I.M.S.

Pestis Minor.

21. Death from *Pestis minor* probably never occurs, but, at any rate, no description of the pathology of plague deals with this type.

Pestis Major.

22. *Lymphatic System.*—(a) *Buboes.*—The appearance of the buboes was characteristic. As we have already stated, they varied much in size and to a less extent in number.
1419. For the most part they consisted of enlarged lymphatic glands surrounded by extravasated blood and serum, which in many instances extended widely and deeply into the neighbouring areolar tissue, and often penetrated into the substance of muscles. Sometimes only one gland was included in a bubo, but more frequently there were

eral, and at times an external bubo was directly connected with one involving deeper ted neighbouring glands, as when a femoral bubo extended inwards so as to be tinuous with one involving the iliac glands. The swollen glands and the surrounding ues were often "matted together . . . so that it was difficult when one cut into it" e bubo) "to be quite sure which was gland and which was the surrounding tissue." e affected glands were round or oval in shape, and they varied in size from that of a l to that of a walnut. On section, they were seen to be much engorged with od, of a light red or deep purple colour, and of firm consistence in some cases, t soft and almost diffluent in others. When the bubo was in the groin, the limb the same side was usually swollen and œdematous; when in the axilla, the serous usion and hæmorrhagic exudation was sometimes so great as to form a swelling volving the whole axilla and extending down the inner aspect of the arm to the elbow, d down the side of the chest nearly to the lowest ribs; and when in the neck a large elling frequently resulted, which pressed upon the larynx, trachea, and cervical nerves d blood vessels, and thus produced the dyspnœa which was so conspicuous a symptom those cases. As buboes in the groin and axilla frequently pressed upon or surrounded e large blood vessels in these regions, the œdema in the corresponding limb is readily counted for.

Proceedings, Vol. I., Appendix XIII., pp. 368, 371. 10,418.

1419; Proceedings, Vol. I., Appendix XX., p. 465. Proceedings, Vol. I., Appendix XX., p. 467.

It has been pointed out by Dr. Childe that in axillary buboes and occasionally in ains of enlarged glands along the course of the iliac artery and vein, the extravasated lood may be continuous with blood in the interior of the veins, thus forming a direct path for the passage of the plague bacillus from the gland to the lumen f the vein, and so into the general circulation."

Proceedings, Vol. I., Appendix XIII., p. 369.

In a few cases of *Pestis major*, no pathological changes were found in other mphatic glands than those in connexion with which buboes had formed; but in most ses, many other glands, and especially the internal glands, were affected. The anges in them, however, were relatively slight, for they consisted only of enlarge- ent, and of either moderate or great congestion, a section of the gland in the latter stance showing much engorgement with dark blood. In individual cases, many r few of the glands were affected; but indeed no lymphatic gland, whether internal r external, seemed to escape involvement, for these changes were observed, in varied oupings, in the bronchial, mesenteric, peritoneal, iliac, lumbar, trochlear, popliteal, nd other glands.

(*b.*) *Lymphatic Vessels.*—In most cases, the lymphatic vessels showed no pathological hange, and in only a few were they observed to be congested and swollen, and that nly close to the bubo.

Proceedings, Vol. I., Appendix XIII. p. 369.

23. *Alimentary System.*—The pharynx and tonsils were greatly congested, the latter eing enlarged and occasionally in a state of follicular inflammation. This congestion sually extended down the œsophagus, and in some cases hæmorrhages were found in ts walls. The stomach was almost invariably engorged with blood, and both minute nd considerable hæmorrhages were present in the mucous membrane. These æmorrhages have been classified by Captain James, I.M.S., as follows :—

1420; 10,419. A Report on Plague, 1897, p. 12.

"(*a.*) A mild form in which, on holding the coats of the stomach up to the light, the course of the smaller vessels was found to be picked out by extravasations which also formed small arborescent patches on the mucous surface, or perhaps only reddened the edges of the rugæ.

"(*b.*) A severe form in which there were more or less extensive patches of hæmorrhage into the sub-mucous tissues or even into the stomach cavity.

"(*c.*) Distinct numerous petechiæ with definite circular outlines and varying in size from a pin's head to that of a split pea. In one case the petechiæ were very numerous and covered nearly the whole of the mucous surface of the stomach. The appearance was so striking that it reminded one of the rash seen on the skin in a severe case of purpura."

Similar appearances have been observed in the intestines. Congestion and hæmor- hagic extravasations were most frequently seen in the large intestine and rectum, and less frequently in the small intestines. Occasionally, Peyer's patches and the solitary ollicles were observed to be swollen. The liver and spleen were enlarged, the latter being sometimes two or three times the ordinary size. Petechiæ were frequently present on the surface of the liver, and its substance was engorged with dark blood, and was soft and friable, indicating degenerative change. The spleen also was generally in a state of acute degeneration, soft and pulpy, and in some cases almost diffluent. On section, it was brick red or deep chocolate brown and always greatly engorged. The gall bladder usually contained bile, and occasionally there were petechiæ on its

1420.

10,421.

Proceedings, Vol. I., Appendix XX., p. 465; 10421.

20,972; Proceedings, Vol. I., Appendix XX., p. 465.

mucous lining. The kidneys were also much enlarged and engorged with blood, and presented the characteristics of acute parenchymatous degeneration. Minute hæmorrhages were sometimes observed on the surface, and petechiæ and coagulated blood in the pelvis and calices. Extensive hæmorrhagic extravasation has also been found outside the kidneys, which then were found "lying in a bed of blood." The ureters and bladder were engorged, and petechiæ were frequently present on their inner surfaces. Besides engorgement, no important change was observed in the supra-renal capsules or thyroid gland, and the genital organs presented a normal appearance. The peritoneum was considerably engorged, but, above all, hæmorrhages, often of large size, were found in many parts, as in the mesentery, in the retro-peritoneal connective tissue, on the under surface of the diaphragm, and over the spleen, liver, kidneys, and intestines.

10,418.

1426; 20,972.

Proceedings, Vol. I., Appendix XIII., p. 369.

24. *Circulatory System.*—The blood was dark and fluid, and gave the impression that it did not coagulate well. The pericardium generally contained more fluid than usual, which was sometimes blood-stained; and minute hæmorrhages were found in both its vesical and parietal portions. The myocardium was generally soft with many muscle fibres undergoing granulo-fatty degeneration; and the right ventricle was always dilated, while in many cases there was also dilatation of the other cavities of the heart. The walls of the larger vessels appeared normal, but those of the veins were engorged, and minute and large hæmorrhages were frequently observed beneath the inner coat. Dr. Childe found that when a large vein was included in a bubo, hæmorrhage into its walls was constantly seen, so that the extravasated blood in the gland itself, in the areolar tissue outside, and in the walls of the vein was continuous.

25. *Respiratory System.*—The larynx was in all cases injected, and in a few instances there was hæmorrhage beneath its surface. In cases of cervical bubo, œdematous swelling involved the soft structures of the larynx and the aryteno-epiglottidian folds. The bronchial tubes were also congested and swollen, and in many cases contained blood-tinged frothy fluid; but the trachea was merely congested. The lungs were engorged with blood and with serous fluid, occasionally small hæmorrhages were found in the lung substance, and when the lungs were cut into much sero-sanguineous fluid escaped. When pneumonia or broncho-pneumonia had occurred as a complication, the pathological changes produced by these diseases were also present. The pleural cavity contained blood-stained or clear fluid. Sub-pleural hæmorrhages, sometimes of large extent, were found on the parietal, visceral, and diaphragmatic pleura; and occasionally there was evidence of fibrinous inflammation. Hæmorrhages were sometimes present in the anterior and posterior mediastina.

20,972.

26. *Nervous System.*—The dura and pia mater of the brain, as well as the coverings of the spinal cord, were congested, and in a few instances extravasations of blood were found on the dura mater. The brain substance and spinal cord generally presented a healthy appearance; but occasionally congestion and œdema were present, which involved likewise the choroid plexuses. No pathological change has been observed in the nerve trunks.

20,972

27. *Bones, Joints.*—It has further been noted that the marrow of the long bones is red and congested as in other infectious fevers, and that evidence of an infective inflammation is found in the fringe-like processes of the synovial membrane of the knee joint.

Intense or Septicæmic Type of Plague.

9541-2.

28. In those cases where the plague virus or toxin is in the patient widespread from the beginning of the illness, so as early to produce a general poisoning, whether septicæmic or toxæmic, the pathological changes, as might be expected, are much the same as in the more severe cases of *Pestis major*. Some observers, however, believe that pathological differences occur to distinguish this form of plague, and to serve, along with the symptoms, as a justification for the establishment of a so-called septicæmic type of this disease. They consist of the absence of buboes having the characters above described, and of a widespread involvement of glands, with distinctive changes in several of them. Although the lymphatic glands are always affected in place of the affection consisting of one or, more rarely, of several groups of gland being enlarged and surrounded with sero-sanguineous extravasation, while the othe glands are either normal or merely enlarged or congested, in this, the so-calle

septicæmic form, the affection of the glands shows itself as a general involvement of all, or nearly all, of the lymphatic glands of the body, although in many instances the affected glands were chiefly those of the mesentery. In no case, however, did the involvement proceed to the formation of characteristic plague buboes, but only to a moderate degree of change, practically restricted to the glands themselves, but still displaying in several of them certain distinctive characters. These were moderate 1421. enlargement and œdema without much congestion, the glands being pink in colour, firm and rounded, and with a softish interior, often possessing here and there small areas of softening surrounded by firm substance. Several of the affected glands may be thus modified, while others of them are merely enlarged and engorged with blood, thus resembling the less affected glands of ordinary *Pestis major*. Excepting the lymphatic glands, the parts that were affected showed essentially the same pathological changes as in the bubonic variety of *Pestis major*, but usually the number of parts affected was smaller and the degree of change in them was less.

Pestis Pneumonica or Pulmonalis, or Primary Plague Pneumonia.

29. Inflammation of the lungs occurs, as already stated, with considerable frequency during the course of plague, and it then becomes a serious complication. It also occurs so early in the disease as to justify the belief that the plague virus had affected the lungs either primarily or coincidently with the more general affection of the body, thus constituting a form of plague which is distinguished as Primary Pneumonic plague. When contrasted with those occurring in *Pestis major*, the pathological changes elsewhere than in the lungs are less intense, while those in the lungs are more intense. The lymphatic glands are only slightly affected, and external buboes having the specific 1388; characteristics seen in *Pestis major* are seldom, if ever, encountered. Congestion and 6913; enlargement of organs and even hæmorrhage in mucous and serous membranes may be Proceedings, present, but they do not assume the proportions attained in *Pestis major*. On the other Vol. I., Appendix XIII., p. 368. hand, the lungs are conspicuously affected. The whole substance is engorged, the Gatacre's Report, large as well as the small blood vessels being distended; and hæmorrhagic zones are p. 140; 17,247. seen scattered throughout the lungs, filling the alveoli and often breaking down their walls. Within the hæmorrhagic zones are areas in which the alveoli are completely filled with leucocytes, epithelial cells, and granular débris, constituting, with the surrounding zones of hæmorrhage, blood-congested areas of catarrhal pneumonia. In these areas, as well as in the fluid matter contained in the trachea and bronchi, plague bacilli are abundantly present. Greyish necrotic patches have also been found containing large numbers of plague bacilli. The bronchi are engorged with blood, and catarrhal cells are found in their terminations. Over affected areas at the surface of the lungs, the pleura may be acutely inflamed. In most cases, the bronchial glands were congested, and there was a little hæmorrhage into the gland substance; but in some cases, their appearance was normal.

While, however, a catarrhal inflammation of lobular distribution has most 10,431; 20,830. frequently been regarded as the characteristic type of primary plague pneumonia, several observers have denied its existence, and have asserted that croupous (lobar) pneumonia is the form that most frequently occurs. Major Evans, I.M.S., and Captain 6914; 9549. Elphick considered that all cases of typical plague pneumonia come under the latter category, and Major Jones expresses the opinion that "lobar pneumonia is common." Major Evans stated that the pneumonia is distributed in small detached patches, constituting lobular areas, only when the inflammation has not advanced far; but that it is lobar to the extent of involving a whole lobe or the greater part of a lobe when the lung inflammation had advanced further. Captain Elphick, I.M.S., described several autopsies in which individual lobes or even an entire lung were consolidated, and he stated that "every case of pneumonic plague examined showed lobar condensation." It may further be stated that in many cases only slight changes were found in the bronchi. It is therefore possible that the pneumonia is lobular in patients who have died at an early stage of the disease, and lobar in those who have survived to a later period; or, otherwise, that lobar pneumonia occurs when the toxin is most virulent and most widely distributed throughout the lung, and lobular pneumonia when it is less virulent and less widely diffused.

A description of the microscopic examination of many of the tissues is contained in Captain Childe's Report. Apart from the distribution of the plague bacillus, which is elsewhere dealt with, microscopic examination has mainly shown general dilatation and engorgement of the veins and smaller blood vessels, and numerous capillary and larger hæmorrhages in almost every structure and organ of the body.

Summary of Pathological Conditions.

20,972; Proceedings, Vol. I., Appendix XVII., pp. 439–40; 9557–64; 17,247; 26,409; Choksy's Report, p. 54.

30. The distinctive pathological changes produced by the virus of plague would therefore appear to consist of universal dilatation and engorgement of veins and smaller blood vessels, with hæmorrhages, both minute and of large amount, in nearly every part of the body, and of enlargement of the lymphatic glands, with œdema and hæmorrhage in the surrounding tissues, generally mainly implicating the external glands, but occurring likewise throughout the body and involving, in a series of cases, the entire system of lymphatic glands. In the lymphatic glands, the characteristic conditions are largely explainable by vascular changes, and even in the pneumonia of plague, vascular dilatations and hæmorrhagic extravasations give a special character to the lung inflammation. In no other infective disease are these features represented, but it is of some interest to note that the vascular changes, and especially the pervading and characteristic tendency to extravasation of blood in almost every part of the body, are closely reproduced in the toxæmia caused by the organic poison secreted by the venom glands of several species of serpents, such as the black snake (*Pseudechis porphyriacus*) of Australia.

V.—Duration of Fatal Cases.

Campbell's Report, p. 131; Snow's Report, p. 251; 10,208; 12,897; Proceedings, Vol. II., Appendix XLIX., p. 485, J.

1859.

Report on the working of the Daliawadi Plague Hospital, 1897–98, p. 8.

Campbell's Report, p. 131.

3483.

12,897.

Snow's Report, p. 61

17,580.

10,439.

31. The aggregate of several statements of the number of deaths on each day after patients had come under observation, comprising 3,035 fatal cases in all, shows that the largest number of deaths—20·3 and 18·9 per cent. respectively—occurred on the second and third days, and that the number of deaths each day then gradually lessened until the eighth day, after which the daily reduction was large and irregular until the 15th day. In the 3,035 cases, death occurred within 24 hours in about one-sixth, within two days in more than one-third, within three days in more than one half, and within five days in about three-fourths of the cases. By the end of the eighth day 93 per cent. of the patients had died, and nearly all of the small remainder before the end of the 15th day. In several other statements laid before us, in which, however, details are given for only a few days, a greater mortality than the above has been recorded for the earlier days. Dr. Hornabrook found that one quarter died within one day and one half within two days; Dr. Jadhav that 41·5 per cent. died within the first 24 hours and 65 per cent. within 48 hours; Dr. N. H. Choksy that 37·6 per cent. died within the first day, and 65·7 within the second day; and Colonel Benson, I.M.S., that 13 per cent. died within 12 hours and 40 per cent. within 24 hours. These discrepancies are no doubt to be accounted for, in some instances, by differences in the virulence of the disease at different times and places, and, in other instances, by inequality in the promptness with which cases were discovered or removed to hospital. The longest recorded duration of a fatal case seems to have been one month and eight days, but the death was due rather to great weakness produced by prolonged suppuration of many buboes than to the direct effects of plague virus. The shortest authentic durations were 3 hours and 14 hours, respectively; but many cases were admitted into hospitals moribund or even dead before admission, in which the duration of illness was not ascertained. Death occurs in pneumonic cases, and generally, but less invariably, also in septicæmic cases, in from less than one day to three days.

VI.—The Mortality from Plague.

See on this subject, 8520; 26,311.

Campbell's Report, p. 130.

Report on Plague in the Mysore State, p. 5; 15,266; p. 137.

32. *Case-Mortality.*—In regard to variations in mortality during different periods of an epidemic, much interesting information has been placed before us. Dr. Choksy has drawn attention to the circumstance that the Bombay City epidemic has distinctly manifested fluctuations in virulence, illustrated not only by a reduction, at certain stages, in the number of cases, but also in the severity of the disease. The latter was shown in the case-mortality, which followed a regular variation of smallest mortality at the beginning and end of each outbreak, and of greatest mortality in the middle period. This was conspicuously apparent in the outbreak of 1897–98, which gradually reached its highest severity, with the largest number of cases and the greatest percentage mortality, in February 1898, when the death rate rose so high as from 85 to 90 per cent., and then a gradual reduction took place, both in the number of cases and in the percentage of deaths. Similar variations are described by Mr. Madhava Rao and by Mr. R. N. Jadhav, L.R.C.P., and in the account of the medical aspects of plague in General Gatacre's Report on the Bubonic plague in Bombay. Lieut.-

Colonel Henderson has also noticed that mild cases of plague occurred at Hyderabad (Sind), especially at the beginning of the epidemic, and evidence to a similar effect was given by Dr. Simpson with regard to the Calcutta outbreak of 1896. Mr. L. Godinho and K. B. Jadhav, L.R.C.P., Captain James, I.M.S., Dr. Nariman, and Hospital Assistant Cooper stated that towards the end of an epidemic the cases became of a milder type. Further, it appears from the evidence of Captain James, I.M.S., that a limited outbreak may entirely be constituted by mild and non-fatal cases.

26,896; 27,000.
18,043.
15,112.
Report on Plague, p. 3, and 10,334.
15,907; 15,922.
14,242.
10,334-7.

These variations, as well as the different prevalence at different times and places of the several types of plague, may lead to erroneous conclusions respecting the case-mortality; for more than 90 per cent., and in some outbreaks, even all the cases of pneumonic plague have proved fatal, while the mortality of the septicæmic is greater than that of the standard bubonic type of *Pestis major*.

6861; 7343-5
9549-56; 12,394;
Campbell's Report, p. 138.

In the case of hospitals, the variations have also been great, and in not a few instances the published statistics are confessedly inaccurate. Summing up a large number of their tabular statements, from which, so far as possible, those containing fallacies were excluded, 15,840 hospital cases have been collected, of which 4,200 ended in recovery and 11,640 in death, representing a case-mortality of 73·48 per cent. In individual statements included in this total, the percentage of deaths varied from 60 to 80·6, but in others, not included, it varied from 0 to 100.

Campbell's Report, pp. 107, 118, 132, 134, 149; Snow's Report, p. 238; Gatacre's Report, p. 109; 18,092; 21,685; 22,258; 25,024; 14,443; 15,266; Proceedings, Vol. II. Appendix XLIX., p. 485, K.

It is, therefore, apparent that estimates of the case-mortality may differ greatly in different places and at different times, and that, in order to obtain a true estimate, it is necessary to deal with as many cases as possible, derived from a large area, and including as long a period of epidemic existence as possible.

Gatacre's Report, p. 148.

For this purpose, the Plague Statistics published for each week by the Government of Bombay are available. They show that in the Bombay Presidency, and in the several Native States connected with this Presidency in which plague had occurred, the total number of cases of plague, excluding cases in Europeans, from September 1896 to 1st June 1900, was 392,385, and that 308,140 of these cases terminated in death, giving a case-mortality of 78·53 per cent. Owing to the large concealment of patients in native houses, where the conditions for recovery were almost hopelessly unfavourable, it may be assumed that the case-mortality was even greater than 78·53 per cent. The highest recorded case-mortalities occurred in Bombay City (83·7 per cent.), Cutch (82·5 per cent.), and Bijapur (81·6 per cent); and the lowest case-mortality in the Sachin State (59·3 per cent). While the case-mortality of the Native and other permanent inhabitants of India was thus high, it was only 29·2 per cent. among the 202 Europeans who became infected in the same period of time (see Appendix III. paragraph 85).

Return dated 1st August, 1900.

No equally complete statistics are available for the Bengal Presidency, nor for any other of the largest districts of India; but during the earlier stages of the outbreak in Calcutta (1898), the mortality in 190 cases was 81·5 per cent.*

Proceedings, Vol. I. Appendix XX., p. 474.

33. *Sex Mortality.*—The mortality from plague does not appear to differ in the two sexes to any striking extent. Taking nine collections of statistics, with a total of 5,449 cases of plague in which there are 3,857 male patients and 1,592 female patients, the deaths in the former amount to 2,911 and in the latter to 1,183, giving a percentage of 75·47 for the male patients and of 74·3 for the female patients. In four other groups of collected cases, in which the deaths in the two sexes are, however, noted only in percentages, an excess of female deaths is shown in two of the groups, namely, 68·6 per cent. of male deaths and 71 per cent. of female deaths in the one, and 58·47 per cent. of male deaths and 64·04 per cent. of female deaths in the other; but the number of cases represented in the two groups is only 672, whereas the average percentage of the four collected groups, comprising 5,294 cases of plague, gives 71·15 per cent. of male deaths and 69·37 per cent. of female deaths. Although it has undoubtedly occurred in a few districts and hospitals that the female deaths have preponderated, it accordingly appears that a larger experience demonstrates a higher case-mortality among male than female patients. At the same time, a great fatality has been observed in pregnant women. After the third month of pregnancy, the percentage of deaths was at least 80, and abortions nearly always occurred.

Gatacre's Report, p. 111; Proceedings, Vol. II., Appendix LXIX., p. 485, G.; Appendix LXX., p. 474; 7221; Dr. Choksy's Report, p. 218, Table iii; Gatacre's Report, p. 132; Campbell's Report, p. 139; Proceedings, Vol. II., Appendix XLIX., p. 485, K.; Vol. I., Appendix XX., p. 474.

Gatacre's Report, pp. 69, 150, 111; Jadhav's Report, p. 28; James' Report, p. 16.

Gatacre's Report, p. 66.

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* Since this was written, full details have been received regarding the Calcutta outbreaks of 1898, 1899, and 1900. In 1898, the recorded number of cases was 242 and of deaths 203, showing a case-mortality of 83·88 per cent.; in 1899, there were 2,467 discovered cases and 2,341 deaths, or a percentage of 94·9 deaths; and in 1900, the number of discovered cases was 8,822 and of deaths 8,278, implying a case-mortality of 93·8 per cent. It may be noted that this rapidly increasing growth and very high mortality have occurred notwithstanding the careful and wholesale disinfection with chemical substances of every house known to have contained a plague patient, and, latterly, even of numerous non-affected houses, and that chemical disinfection appears to have been the only plague measure that was consistently applied in this City.

Report of the Epidemics of Plague in Calcutta, by W. R. Bright, I.C.S., 1900; Official Statement showing the number of Plague Attacks and Deaths in the town of Calcutta.

Gatacre's Report, p. 111; Jadhav's Report, p. 29; Snow's Report, p. 249; 7221; Proceedimgs, Vol. I., Appendix XIV., p. 391, Tables I. and II.; Campbell's Report, p. 140; Dyson and Calvert's Report, p. 6

34. *Age Mortality.*—Plague appears to be least fatal to very young and very old persons. In 4,215 cases collected from the statistics of seven observers, the percentage mortality among those of one year and less was 12·5. The rate of mortality rises to 75 per cent. for the ages betwen one and five; it then falls to 69·1 for the ages from five to ten; and it very gradually, and with almost perfect regularity, rises in each subsequent decade, until it obtains the high rate of 80·2 per cent. between the ages of 50 and 60. From 60 upwards there is a fall in mortality to 67·5 per cent., and the evidence appears to show that in persons of a very advanced age, such as 70 and upwards, the death rate becomes so low as 50 per cent.

Snow's Report, p. 218; Campbell's Report, pp. 132, 139; 25,015; 7221; 12,897; 14,443; 13,692; Jadhav's Report, pp. 9, 28; James' Report, p. 17; Proceedings, Vol. II., Appendix XLIX., p. 483; Vol. I., Appendix XX., p. 474; Campbell's Report, p. 48; Proceedings, Vol. I., Appendix XIV., p. 391.

35. *Race and Caste Mortality.*—A number of cases showing the death-rate in the chief races and castes have been collected from fourteen sources, representing nearly all the hitherto plague-affected districts of India. These cases amount in all to 14,668, but in some instances the numbers of individual races are only small. The Hindus with 9,302 deaths in 11,582 cases, yield a death rate of 80·3 per cent.; the Jews with 35 deaths in 45 cases, a death rate of 77·7 per cent.; the Musalmans with 1,247 deaths in 1,671 cases, a death rate of 74·63 per cent.; the Native Christians with 798 deaths in 1,115 cases, a death rate of 71·56 per cent.; the Eurasians with 76 deaths in 132 cases, a death rate of 57·6 per cent.; the Parsees with 38 deaths in 66 cases, a death rate of 57·6 per cent.; and the Europeans with 24 deaths in 54 cases, a death rate of 44·4 per cent.* Deductions are perhaps untrustworthy from the small number of Jews, Parsees, and Europeans; but it is believed that the majority of the Jews affected were derived from the lowest class of that community, and it is well known that the Parsees resemble Europeans rather than Natives in their mode of living. The above numbers are, however, sufficient to warrant the statement that the greatest mortality from plague has occurred among the Hindus, Musalmans and Native Christians, and very much in the ratio indicated by the above figures. Only a very few Chinese or Burmese are represented in the 14,668 cases dealt with, and, so far as the figures go, the percentage of deaths among them has been very high.

Campbell's Report, p. 137; Gatacre's Report, p. 110. Snow's Report, pp. 220, 221.

Proceedings, Vol. II., Appendix XLIX., p. 484.

22,269.

36. *Mortality according to Occupation.*—Although in Bombay, mill workers, coolies, and domestic servants were among those most largely affected by plague, these classes, at the same time, furnished the smallest case-mortality, while the largest case-mortality occurred among syces, milkmen, tailors, ayahs, and washermen. In domestic servants the rate was 65·4, in shopkeepers 71·4, in coolies 72, and in millworkers 77·2 per cent.; but in syces and milkmen it was 89·47 and 86·66 per cent., respectively. In Porbandar, in a few cases in which washermen, barbers, and goldsmiths were attacked, the mortality was extremely great, and greater than among beggars, domestic servants, labourers, and corndealers and grocers, in whom it varied from 77 to 65 per cent. In Satara, the death rate was so high as 88 per cent. among gardeners, 85 per cent. among barbers, 80 per cent. among tailors, and 71 per cent. among scavengers; and the four washermen who acquired plague all died.

Campbell's Report, p. 138.

Campbell's Report, p. 115.

Gatacre's Report, p. 49.

Report on Poona Outbreak, p. 18.

A short Report on the Plague in Bombay, &c. p. 3. 209,52; Snow's Report, p. 250.

37. *Mortality according to Position of Buboes.*—There is a difference of opinion, supported in several instances by statistical evidence, as to whether, in cases having buboes, the greatest mortality does or does not occur when these buboes are situated in the axilla. Dr. Hutchinson, dealing with 854 cases of plague, and Captain Jennings, with 992 cases, show that in their cases the greatest mortality is associated with groin buboes; in Dr. Hutchinson's cases the percentage of deaths being in groin buboes 91·61, in axillary 85·8, and in cervical 84·8. On the other hand, Captain Thomson, I.M.S., finds that the per-centage mortality in 238 cases was in groin buboes 56·1, in axillary buboes 73·41, and in cervical buboes 65; Captain Lloyd Jones, in 2,244 cases, in groin buboes 67·52, in axillary buboes 74·89, and in cervical buboes 72; and Mr. R. N. Jadhav, L.M. and S., in 476 cases, in groin buboes 64·47, in axillary buboes 78·72, and in cervical buboes 52·94. Dr. Dyson and Captain Calvert and the majority of those who have given evidence on this subject have also stated that the greatest mortality occurs in patients with axillary buboes; and Dr. Choksy's figures lead to the same conclusion with regard to cases having single buboes, but at the same time show that, when, in the same patient, buboes occur in the femoral and iliac glands the mortality is slightly greater than in patients having only axillary buboes, the respective percentages being 83·33 and 82·35. It may, therefore, be concluded that cases with axillary buboes are the most fatal; and the frequency with which extensive effusion, sloughing and hæmorrhagic extravasation are associated with

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* Where the number of Europeans is considerably larger than in these collected statistics, the death-rate is found to be even lower than 44 per cent. (*see* preceding page).

these buboes probably accounts for the great fatality which accompanies them. Among patients with cervical buboes, those in whom the parotid glands were implicated scarcely ever recovered.

Campbell's Report, p. 141.

Relatively to the side of the body in which these, the most frequently encountered buboes, occur, there is some evidence to show that in cases with groin and cervical buboes the mortality is almost the same whether they occur on the left or right side, but that in cases with axillary buboes it is greater when they occur on the left than on the right side; for example, in 466 cases with axillary buboes the percentage of deaths was 75·3 in buboes on the right and 82·6 in buboes on the left side. In regard to the mortality in the two sexes relatively to the position of the buboes, the evidence is not large in amount, but, so far as it goes, it appears to show that in cases with groin, axillary, and cervical buboes the percentage mortality on the total number of cases of each in the two sexes is always greater among men than women.

Lloyd Jones' Report on the Poona Outbreak, p. 18.

VII.—The Incidence of Plague.

38. *Sex Incidence*—In India, hospital experience appears to show that a much larger number of men than of women had become affected with plague. Captain Jennings, I.M.S., states the relative numbers as 693 male and 299 female patients; Major Dyson and Dr. Calvert, 133 male and 67 female patients; Mr. Cooper, 910 male and 710 female patients; Dr. Bhatt, 417 male and 93 female patients; Captain Thomson, I.M.S., 368 male and 155 female patients; Dr. Clemow, 331 male and 171 female patients; and Dr. M'Cabe Dallas, 260 male and 114 female patients. The totals of these numbers show 3,388 male and 1,512 female patients, or nearly twice as many male as female patients. In some places, as Poona, the disproportion was even greater than in any of the above instances. According to Lieut.-Colonel M'Conaghy, I.M.S., of 152 cases treated in the Sassoon Hospital, 136 were male and only 16 female patients, giving a ratio of more than eight to one. It would not, however, be justifiable to infer that the plague incidence is to a corresponding, or to any remarkable extent, greater among males than females, for in many cities of India the proportion of males is in excess of that of females,* during panics a larger number of women than men would probably leave affected towns and cities, and as the above figures represented admissions into hospitals, it is not unlikely, owing to caste prejudices regarding women, that a larger proportion of affected men than women were removed to hospitals. A truer indication, however, of sex incidence would be derived from the relative numbers of the two sexes in a general as distinguished from a hospital population. Evidence of this kind was obtained at Baroda and is specially valuable from this point of view. According to Rao Bahadur K. V. Dhurandhar, among 3,685 plague cases which occurred in the urban and rural districts of Baroda State, 1,995 were male patients and 1,690 were female patients, showing a fairly equal number in the two sexes. It may, therefore, be assumed that there is no special sex incidence in plague, both sexes being equally liable when subjected to plague infection, under conditions favourable to the propagation of the disease.

Campbell's Report, p. 115; Report on Plague in Bombay, p. 5; 15,363; Campbell's Report, p. 151; Gatacre's Report, p. 48; Proceedings, Vol. I., p. 257, 7221; Gatacre's Report, p. 111.

12,897.

Proceedings, Vol. I., Appendix VIII., p. 352.

15,219.

22,361.

39. *Age Incidence.*—Many tabular statements have been placed before us showing the numbers of plague patients admitted at different ages into hospitals. Summarising those of Captain Jennings, Dr. Parsons, Colonel Thomson, Major Dyson and Captain Calvert, and Dr. Bhatt, amounting in all to 2,741 cases, the numbers admitted at the following different ages were:—Infancy, one patient; one to five years, 46 patients; five to ten years, 186 patients; 10 to 20 years, 647 patients; 20 to 30 years, 988 patients; 30 to 40 years, 491 patients; 40 to 50 years, 225 patients; and 50 years and upwards, 157 patients. The greatest number, therefore, were from 20 to 30 years of age, and following these in number were those between from 10 to 20 and between from 30 to 40 years of age; the first representing 36 per cent., the second 23·6 per cent., and the third 17·9 per cent. of the total. Otherwise grouped, 77·49 per cent. were between 10 and 40 years of age, 59·67 per cent. between 10 and 30, and 57·26 per cent. between 20 and 40.

Campbell's Report, pp. 115, 156; Gatacre's Report, p. 48; Report on Plague in Bombay, p. 6; Campbell's Report, p. 151; Proceedings, Vol. I., Appendix XIV., p. 391.

When, however, the ages of those affected in the general population is examined, several differences from the above are seen. From information supplied by Captain James, I.M.S., and Assistant Surgeon Petigara relating to 4,734 plague patients in the Jullundur District and in Ankleshwar, it appears that 342 were from one to five years old; 525 from five to 10; 1,077 from 10 to 20; 1,021 from 20 to 30; 760 from 30 to 40; 496 from 40 to 50; and 160 from 51 years old and upwards. In this series of cases, the greatest number, 22·77 per cent., occurred between the ages of

10,330; 14,394.

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* In Calcutta, where the number of men is, in ordinary conditions, much larger than the number of women, there were, in the outbreak of 1890, from 14th April to 31st July, 152 male and only 38 female cases. (Proceedings, Vol. I. Appendix XX., p. 474.)

from 10 to 20, in place of between 20 and 30 in the other series. As in the former series, the majority of the cases occurred between the ages of from 10 to 40, but this majority is only 60 per cent. of the total, while it is 77·49 per cent. in the former series. A reduction in number is also seen in each of the three decades embraced in this period; for the percentage to the total between from 10 to 20 years of age is 22·77, between from 20 to 30 years of age, 21·54, and between from 30 to 40 years of age, 16. The plague patients in the general population, on the whole, are more evenly distributed over the different ages than in the case of hospital patients; and, more especially, there is a larger number of young patients, 7·2 per cent. being from one to five years old, and 11 per cent. from five to ten years old, as contrasted with 1·6 and 7 per cent., respectively, in hospital patients. The statistics submitted by Assistant Surgeon Petigara have a further interest that they show the relationship of the numbers attacked at different ages to the population at those ages. 5·15 per 1,000 of the population from infancy to five years of age were attacked; 22·3 per 1,000 from five to ten years of age; 42·5 per 1,000 from 10 to 20 years of age; 34·6 per 1,000 from 20 to 30 years of age; 41·61 per 1,000 from 30 to 40 years of age; 36·25 per 1,000 from 40 to 50 years of age; 31·6 per 1,000 from 50 to 60 years of age; and 19·37 per 1,000 of the population 60 years of age and upwards. These figures likewise show that, although only a small number of children are attacked by plague, the number is larger than is indicated by hospital experience.

Gatacre's Report, pp. 48 and 123.

The youngest patients stated to have been affected with plague were seven months and ten months of age, and the oldest patients were 85 and 96 years of age.

Gatacre's Report, p. 110; Campbell's Report, pp. 132, 115, 139; Snow's Report, p. 217; 25,015; 7221; 12,897; 14,443; 15,642; 13,692; Proceedings, Vol. I., Appendix XIV., p. 391.

15,219.

40. *Race and Caste Incidence.*—In India, hospital statistics are not altogether trustworthy foundations from which to draw inferences regarding the racial or caste incidence of plague. In any given place, the numbers of each caste were not accurately known during the time of the outbreak, and variations occurred in the readiness with which members of different castes entered hospitals; while in certain places hospitals restricted to special castes were provided, which served to increase the numbers of these castes who were treated in hospitals. These causes of fallacy may to some extent be reduced by grouping together the statistics of hospitals in a considerable number of places. When that is done, it is found, in a collected total of 12,240 cases of plague, that 9,222 were Hindus, and 1,606 were Muhammadans, these two predominating sects thus together accounting for 88 per cent. of all the cases; and that 1,090 were Native Christians, 122 Parsees, 108 Eurasians, 52 Europeans, 29 Jews, and 11 Goanese. The Hindus, therefore, represent 75·34 per cent. of the total; the Muhammadans, 13·12 per cent.; the Native Christians, 8·9 per cent.; and the Parsees, 1 per cent.: the other groups together representing 1·6 per cent., of which only 0·42 per cent. were Europeans. The great preponderance of Hindus, followed, though by a long interval, by Muhammadans, is accentuated when the members of each caste or race are determined in a general as contrasted with a hospital population; for in the Baroda State, out of 3,760 cases of plague that occurred from the 1st of October 1896 to the 30th of June 1898, 3,200, or 85·1 per cent., were Hindus; 429, or 11·4 per cent., were Muhammadans; and 44, or 1·2 per cent., were Parsees. On the other hand, in Calcutta, where plague is believed to have followed in several respects an exceptional course during the first outbreak, the preponderance of incidence among Hindus was not so conspicuously displayed. Dr. Nield Cook has shown that out of 190 cases, 105, or only 55·2 per cent., occurred among Hindus; 56, or so many as 29·5 per cent., among Muhammadans; 24, or 13 per cent., among Eurasians; and two among Chinese, one among Burmese, and one among Europeans.

Proceedings, Vol. I., Appendix XX., p. 474.

Proceedings, Vol. II., Appendix XLIX., p. 484; Madhava Rao's Report, p. 21.

A truer conception of the caste incidence might be gained by calculating the number of cases that have occurred in each caste in an affected place. The data for such calculations, however, are limited to only a few places. They have been supplied, with some obvious uncertainties, regarding outbreaks in Porbandar and in the Bangalore District. In the former, where only 18,805 persons and 465 cases of plague are dealt with, the incidence is the same in Hindus and Muhammadans, being 2·5 for each caste; but in the latter, involving 622,628 persons and 4,992 cases of plague, the incidence among 584,083 Hindus is ·65 per cent., and among 34,863 Muhammadans 3·2 per cent. This large and exceptional incidence among Muhammadans is thus commented on by the Deputy Commissioner:—"From the experience so far gained no deductions can be drawn as to the greater or lesser liability of any particular sect or class to succumb to an attack of plague, but it is abundantly clear that the dirtier and worse ventilated the dwelling the greater the liability of the occupants to catch and succumb to plague."

On the whole, there appears to be among the permanent inhabitants of India a general accordance between the number of cases of plague in each caste or race, and the number of the caste or race in the affected community; but the variations that occur in many places and between several races suggest that local conditions strongly operate in the distribution of the cases of plague. It has, for example, been pointed 14,446. out by Assistant Surgeon Petigara that only an insignificant percentage of cases occurred among the Bhils of Ankleshwar as contrasted with the high percentage among 14,449. other sub-classes of Hindus, due to the Bhils living "on the outskirts of the town, and to the open-air life they led."

41. *Occupation Incidence.*—The statistics laid before us in regard to occupation incidence are inconclusive, as the numbers are small, and as great variations occur in different places. In Bombay, coolies, mill workers, labourers, syces, domestic servants, beggars and persons without fixed occupation furnished the largest numbers of plague patients. In Porbandar, the largest numbers were furnished by labourers, boatmen, sailors and fishermen, beggars, corn dealers and grocers, and domestic servants. In Satara, gardeners, tailors, barbers, scavengers, goldsmiths, shoemakers, tanners, oil pressers, and brass founders were the chief victims. Plague occurred in only a few washermen, and prostitutes and wandering beggars nearly altogether escaped. The evidence, generally, is in the direction of showing that, with equal opportunities for personal infection, the incidence of plague is not dependent on the trade or occupation, but rather on the conditions of living, whatever be the occupation. This has been illustrated by many examples, as, for instance, by the occurrence of a much larger number of plague cases among the members of the Bombay Police Force living in ordinary native houses than among those living in the well-ventilated police barracks; and by the freedom from plague of the rice cultivators at Satara, although they lived in huts in the midst of an infected area, which has been explained by their working from morning to night in the open air during the rainy season; and by the immunity of fakirs, whether Hindu or Muhammadan, who live a specially open-air life.

Proceedings, Vol. I., Appendix XIV., p. 392; Campbell's Report, p. 137; Gatacre's Report, p. 110; Snow's Report, p. 221. Proceedings, Vol. II., Appendix XLIX., p. 484. 22,266–9.

Snow's Report, p. 147, para. 566; 22,127–8.

VIII.—DIAGNOSIS.

42. *Pestis major.*—So preponderating is the number of cases in which plague assumes the type of *Pestis major* that it must be regarded as being generally an easily diagnosed affection. In this type of it, the peculiar expression, the early occurrence of fever and 27,138. prostration, the existence of a bubo or buboes that are painful and tender, the congested eyeballs, the furred tongue with clean red margins, the impaired memory, the indistinct and hesitating speech, and the rapid, weak, and often irregular pulse, are alone sufficient to render the nature of the case unambiguous. It could only be at the beginning of an outbreak that doubt might be suggested by cases of such diseases as malaria, remittent or relapsing fever, congenital syphilis with enlarged glands, scrofulous glands or parotitis. In some of the less frequently encountered varieties of this type, however, the diagnosis is attended with difficulty. In the variety in which bowel complications occur it may for a time be mistaken for dysentery or enteric fever. In the rare septicæmic variety, in which rapid prostration usually occurs without the production of external buboes, the diagnostic features may be so masked as to suggest doubts which cannot always be removed during life even by bacteriological examination. In many of these cases, however, bronchitic and pulmonary complications yield 20,618–9. a sputum in which plague bacilli are present.

Proceedings, Vol. I., Appendix VIII., p. 352. Campbell's Report, p. 160.

43. *Pestis minor*, in each of its varieties, must always present difficulties when the diagnosis is based merely on the symptoms of individual patients. In the variety with glandular enlargements, the transient fever may prove of assistance, but the nature of the illness will more often be determined by excluding causes of glandular enlargement other than plague, such as strains, traumatic injuries, scrofula, venereal disease, and ulcers. In the variety without buboes, the diagnosis of an individual case is probably impossible. In both varieties, however, practical certainty may be obtained, when, in addition to the above circumstances, it is found that cases of a similar nature are prevalent, and evidence of infectivity is thus obtained.

44. *Primary Plague Pneumonia* is distinguished from ordinary pneumonia by the great severity of the general symptoms relatively to the manifestations of lung disease, and especially by the high temperature, rapid respirations, and great prostration; by the generally isolated and scattered distribution of the involved portions of lung; by the slightness of the symptoms of lung disease; and by the special characters of the 15,666. sputum. Microscopic examination of the sputum at all stages of the illness reveals the presence of plague bacilli, and, therefore, in this type of plague, is of specially easy application.

Microscopic examination of the sputum is also applicable as a means of diagnosis in 18,906; 18,908. the secondary pneumonia and broncho-pneumonia of plague, and of the material obtained 18,907.

from non-suppurating buboes in ordinary *Pestis major*. Mere microscopic examination of the blood in all types of plague, including the septicæmic, as well as of material from a bubo in *Pestis minor*, would, however, most frequently prove inconclusive; for
4330-5; 18,913; 26,261-2. in all types of plague, bacilli are generally present in the blood in only small numbers,
and usually only a few hours before death, while very few are present at any time in the buboes of *Pestis minor*. Definite results could be obtained only by culture
26,402. experiments and experiments in animals, both of which, obviously, are possible only in exceptional circumstances.

26,220-6; 2965-80; Proceedings, Vol. I., Appendix XV., p. 398. The agglutination or sedimentation test and Widal's reaction are largely open to the same difficulties of application; but, in any case, trials made of them in India have proved inconclusive.

45. *Post-mortem Diagnosis.*—The body, if undisturbed, is stated to be generally lying on one side, with the knees flexed, and the head slightly bent on the chest. The skin is
Gatacre's Report, p. 147. dry, and in a few cases petechiæ and purpuric spots may be seen; the muscles are soft, as the rigidity of death is delayed; the features retain a fixed anxious appearance; the eyes are half closed and sunken, with the pupils dilated; and the tongue is swollen, and although it sometimes has the appearance displayed during life and already described, not unusually it is covered with a dry, almost horny, dark or yellowish brown and cracked fur. In pneumonic cases, the body seems specially shrunk and collapsed and has a livid aspect, and blood-stained sputum is often found adhering to the lips.

9544. Our attention was drawn by Captain Elphick, I.M.S., to the existence of œdema, extending over the front and sides of the chest, the abdomen and the upper part of the arms, which had been observed by him and by Captain Chaytor-White, I.M.S., in
10,345; 10,379-83. all plague corpses, and was believed to occur immediately before death. If this
10,424-9. 12,403-8. condition is generally present, it would be valuable as an aid in determining if death had
12,925; 15,926. been caused by plague, and especially in cases where no buboes are present. It has not,
18,557. however, been observed by the great majority of those who in India have had the opportunity of seeing large numbers of fatal cases both before and after death.

IX.—PROGNOSIS.

46. With a general mortality in fully developed plague of from 60 to 90 per cent., indicating a virulence exceeding that of any other epidemic disease, the prognosis of plague is in India extremely grave.

12,413. The chances of recovery are smallest in pneumonic plague, and somewhat better, though still inconsiderable, in the variety of *Pestis major* in which a profound intoxication has been rapidly produced, distinguished as the Septicæmic variety, and also in cases of *Pestis major* with extensive cellulitis proceeding from axillary or cervical buboes. The prognosis is graver in patients with axillary and parotid buboes than with buboes in other situations; in Hindus and Muhammadans and others living in the usual conditions of native existence, than in Europeans or those living in similar conditions to them; and in patients from one to five and from 50 to 60 years of age than at all other periods of life, and especially than the very young and
12,413. the very old. It is stated to be less favourable in obese and heavy patients than in
20,910; 27,028; Proceedings, Vol. I, Appendix VIII., p. 352; Madhava Rao's Report; Snow's Report, p. 247; N. H. Choksy's Report on Bubonic Plague, p. 39. those of moderate or light weight; but it is in harmony with general observation that the most robust and well fed are attacked and succumb to the disease equally with the feeble and poorly fed. Among the chief circumstances that indicate an unfavourable termination are a very high temperature, "or a sudden fall, sudden extension of infiltration, the simultaneous appearance of buboes in other parts of the body, sharp diarrhœa and intense dyspnœa." An unfavourable termination is also indicated by great weakness of the pulse, hypostatic congestion and œdema of the lungs, secondary pneumonia or broncho-pneumonia, convulsions or early and violent delirium, and hæmorrhage from any surface or organ of the body. As any or several of these
12,413; Gatacre's Report, p. 124; symptoms may occur when the condition of the patient was until then altogether favourable, the prognosis of every case of *Pestis major* is uncertain during the earlier
15,677-9; 12,413. period of the illness. It is, however, a distinguishing feature in the prognosis of plague that usually the period of suspense extends over only a few days; for nearly all who survive until the eighth day, rather less than four-fifths of those who survive until the fifth day, and more than one half of those who survive until the third day may be expected to recover.

X.—TREATMENT.

47. The treatment of plague includes—(*a*) measures for preventing the development of the disease in persons who have been exposed to infection, as well as (*b*) measures for curing the already developed disease.

(*a.*) *Prophylactic or Preventive Treatment.*—The subject of the prevention of plague has partly been discussed in the Chapter of our Report dealing with Mr. Haffkine's prophylactic injections, and partly also in the remarks separately made by me on the influence of insanitary conditions on the spread and virulence of the disease (Appendix III.).

The evidence appears to indicate that prophylactic properties are not developed by Mr. Haffkine's fluid until some considerable time after the fluid has been injected. If, therefore, the virus of plague have been introduced into the body previously to or a few days subsequently to the injection, the fluid would fail to prevent the development of plague.

On the other hand, sera, such as those of Lustig, Yersin, Roux and Galeotti—although their operation is more generally associated with the treatment of the already developed disease—are capable also of exerting a prophylactic influence, which, while it lasts for only a few days, has the great advantage of being almost immediately produced. In order to reduce the chances of plague occurring in persons who are suspected or are known to have been exposed to infection or who may soon be so exposed, it is therefore advisable to inject subcutaneously one or other of these sera for the purpose of conferring protection. Should no symptoms of plague manifest themselves within eight days, Haffkine's prophylactic fluid may then be injected with the hope of securing a more lasting although less speedily induced protection. At the same time, if the disease should develop itself within a few days after the injection of the serum, it may confidently be anticipated that the severity of the illness will not be so great as it would otherwise have been; for the curative power of a serum possessing therapeutic properties is more powerfully developed when it is administered during the earlier stages of the disease than during the later stages, and with still greater prospects of success when it is administered shortly before the reception of the virus.

The sera and prophylactic preparations at present available possess, however, only moderate and limited protective power, sufficient, nevertheless, to warrant their use, but insufficient to justify an entire trust in their employment. A generally available preventive, and, in the meantime, the most certain of all preventives, is the maintenance of good hygienic conditions. An open-air life and adequate lighting and ventilation of dwellings, with the removal from them of overcrowding and all other causes of air pollution, have been amply shown in the Indian and in other epidemics to confer effective protection. Whatever other measures are employed, these should receive the first attention and should in no circumstances be overlooked or neglected.

48. (*b.*) *Therapeutic or Curative Treatment.*—Although the mortality from plague in hospitals, especially when those patients are excluded who were admitted moribund or nearly so and who died within 24 hours, is smaller than that of the town where the hospital is situated, it is not easy to appreciate how far this reduction was caused by medicinal treatment. The good hygienic conditions, and especially the pure air and absence of overcrowding and the efficient nursing arrangements, constituting in each respect a strong contrast with the conditions to which patients in the vast majority of cases were subject in their dwellings, could not fail to have a favourable effect on the progress of the illness. At the same time, there are clear indications for medicinal treatment which have been followed and have probably aided in reducing mortality, although their benefit cannot at present be stated definitely.

Snow's Report, pp. 216, 248; Gatacre's Report p. 150; Lloyd Jones' Report, p. 16; A Report on Plague, by Captain James, I.M.S., 1897, p. 16.

In the general treatment of patients, experience has strongly emphasised the necessity for abundance of fresh air, for complete, passive repose, strictly to be continued for at least four days after the temperature has become normal, and for the maintenance of strength by the frequent administration of food in small quantities and by the liberal use of alcoholic and other stimulants.

The more strictly medicinal treatment has been in the directions of furthering elimination, of endeavouring to reduce the hurtful power of the virus within the body by the administration of substances intended to act directly upon it, of reducing temperature, of strengthening the circulation, and of removing such symptoms of the disease as sleeplessness and delirium.

Purgatives, and especially calomel, have accordingly been largely used at the commencement of treatment, and diuretics or diaphoretics as indicated in the course of the illness. The increasing of elimination is also believed to be a chief advantage of a plan of treatment, which has been recommended to our notice, consisting of subjecting the patient to a vapour bath at the temperature of 112° F., followed by partial immersion in water gradually cooled from about 99° to 80° or 75°, and by friction of the skin; but we had no opportunity of obtaining verbal evidence with regard to it. The effect on mortality is not clearly favourable, as 72·7 per cent. of the patients died. The treatment produces much diaphoresis, and also, it is claimed, profuse diuresis.

Gatacre's Report, pp. 69, 142; Snow's Report, p. 252; Captain James' Report on Plague, p. 16; Dyson and Calvert's Report, p. 16; Lloyd Jones' Report, p. 9; 1860.

Proceedings, Vol. II., Appendix A., p. 527.

The latter, however, is not manifest from the statement which has been submitted. Before an opinion can be formed as to the merits of this plan, observations on a more extended scale, with precautions to exclude several fallacies, would be required, especially as the weakness of the circulation, so conspicuous in plague patients, suggests that the plan of treatment is likely to be attended with danger.

Proceedings, Vol. I., Appendix VIII., p. 353; 20,934–71; 21,050–2; 27,030–64.

Undoubtedly, the rational therapeutics of plague, as of all other bacterial diseases, is to be found in the administration of substances capable of rendering innocuous the specific virus within the body of the patient. The results with the several anti-toxic sera designed to accomplish this, which have been used in India, are certainly encouraging, and justify the hope that with sera of greater bactericidal and anti-toxic power than those hitherto prepared more definite therapeutic benefit will be obtained. To obtain the best results, the serum should be injected at as early a stage in the illness as possible, the quantity should be large, and the injections should be repeated for several days even although the temperature of the patient and the general condition have been much improved by the previous injections. In severe cases, and certainly in the pneumonic and septicæmic forms of plague, the serum should be injected directly into a vein, for the therapeutic power of a serum is much greater when it is injected into a blood vessel than when it is injected into the subcutaneous tissues. At the same time, it is not probable that a serum will ever be prepared which is capable, even by intravenous injection, of preventing death in pneumonic and septicæmic plague after grave symptoms have become developed, and, therefore, when the virus is already diffused in large quantities throughout the body. On the reasonable supposition that in bubonic cases the plague bacilli are for a time concentrated in the primary buboes, it is advisable to inject the serum into the buboes or the tissues immediately surrounding them; and it is probable that the best results will be obtained by this plan of administration, which, however, does not appear as yet to have been employed in practice. The subject of therapeutic sera is more fully discussed in Chapter V. of our Report.

22,372; Gatacre's Report, pp. 22, 70, 142; Captain James' Report on Plague, p. 17; 11,905.

11,905

On the same principle, such bactericidal substances as mercuric chloride and carbolic acid have been administered in large doses. It is stated that much benefit was thereby produced, and with a combination of quinine and carbolic acid Mr. Seymour has claimed that the mortality was reduced so low as 25 per cent. An objection to the employment of medicinal substances for this purpose is found in the absence of restriction of action upon the *causa mali*, and a consequent dissipation of power in unwished-for directions; for the most efficient of them equally affect and combine chemically with many of the ordinary constituents of the body, and thereby fail to be present, in their originally active condition, in sufficient quantity to produce an appreciable destructive action on the virus, unless very large and therefore poisonous doses are administered.

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Gatacre's Report, pp. 22, 71; 372.

Snow's Report, pp. 257, 258.

On the supposition that in many cases there is a concentration of the virus in the buboes, preliminary to diffusion throughout the body, several antiseptics, such as mercuric chloride, iodine, carbolic acid, and creoline, have been injected near or into the substance of the buboes. The results were not definitely confirmatory of expectation, although local benefit was believed to be obtained by the process of suppuration having been hastened in the buboes. A more effective application of this principle would probably be found in the substitution of a curative serum for an ordinary antiseptic substance, especially as such a serum, while energetic in its action upon the virus, is free from the objection of extending its action to the tissues and fluids of the body. Even weak sera, such as are at present in use, may be efficient if brought into contact with the virus concentrated in one place, whereas if both were diffused throughout the body the virus will remain unaffected.

Gatacre's Report, pp. 70, 143; Snow's Report, p. 256.

In the endeavour to reduce temperature, to some extent unsatisfactory experience but apparently to a greater extent a supposititious dread of increasing the existing weakness, has restricted the use of anti-pyretic substances such as acetanilide, phenacetin, phenazonum, guaiacol, and even quinine. Reduction of temperature has, however, been obtained, apparently with favourable results, by cold and tepid sponging, and the application of ice to the head.

Gatacre's Report, p. 69; Snow's Report, p. 257.

15,315. 22,376.

As we have already seen, feebleness of the circulation constitutes an early and striking feature of plague. It has accordingly been recognised as a prominent danger demanding special treatment. For this purpose, alcoholic stimulants have been used, and, in many hospitals, a routine treatment for all patients, except Muhammadans and children, was the administration of rum immediately after the admission of the patient. Alcohol and carbonate of ammonia have also been freely given during the course of the illness; but more favourable results have apparently been obtained by the use of medicinal agents, which act more restrictively and powerfully upon the heart and blood vessels. With this object, digitalis and strophanthus have been used to strengthen the heart's contractions, and digitalis and strychnine to counteract the feebleness of the blood vessels. The greatest success appears to have been obtained by the subcutaneous administration of a combination of strophanthus and strychnine, or by combining the administration of digitalis by the mouth with that of strophanthus by subcutaneous injection.

Opium, morphine, bromides, hyosciamine, hyoscine, sulphonal and tetranol have separately and in various combinations been employed to produce sleep and control mental excitement and delirium. Apparently the best results have been obtained by combinations of morphine with bromide of potassium or atropine, and by the application of cold to the head.

Gatacre's Report, p. 59; Snow's Report, p. 256 James' Report on Jullundur and Hoshiarpur outbreaks, p. 148; Jadhav's Report, p. 32; Captain Lloyd Jones' Report, p. 9; Captain Wilkinson, I.M.S., Report to Punjab Government, September 1897, p. 29.

Snow's Report, p. 255.

4328.

There seems to be a consensus of opinion that many medicinal substances are tolerated to an exceptional degree by patients suffering from plague. This has been particularly observed in the case of mercurial preparations, which are stated to produce no salivation in quantities that usually succeed in doing so, and of morphine and strychnine, which have been given in extraordinarily large doses for long periods of time without causing any toxic manifestation. A similar tolerance is claimed for alcohol, but it does not appear to differ from the experience of its effects in many other acute affections.

Gatacre's Report, pp. 70, 71, 102, 142.

Snow's Report, p. 253; Captain James' Report on Plague, p. 17; Dr. Jadhav's Report, p. 33.

4327.

49. *Local Treatment of Buboes.*—While buboes are still in the early stage it has been found that no benefit, but rather injury, has resulted from cauterising or incising them, or from the application of leeches. The practice now followed is to apply extract of belladonna and glycerine, or ice, or strong solution of nitrate of silver. Cauterising or scarifying the surface, or the abstraction of blood by a rude method of cupping, are, however, favoured by unqualified native practitioners. When evidence of the formation of pus is obtained, it is fully recognised that free incision is required, with the subsequent liberal use of antiseptics, of which iodine, mercuric chloride and lysol appear to have been the most generally employed. For reasons that have been stated above, the injection of an efficient therapeutic serum into the bubo is likely to produce beneficial results.

Gatacre's Report, p. 143; Snow's Report, p. 258.

Snow's Report, p. 258; 12,908; Jadhav's Report, p 34; Captain James' Report on Jullundur and Hoshiarpur outbreaks, p. 148.

Gatacre's Report, p. 143; 12,908.

50. *Treatment during Convalescence.*—On account of the great prostration that accompanies and follows an attack of plague, and especially the great weakness of the circulation, the patient should be kept strictly in a recumbent posture until, at least, four days after the temperature has become normal. In such patients as have recovered from the acute condition, the dietetic and tonic treatment obviously indicated has been followed. Iron, quinine, phosphorus and cod-liver oil have been the chief tonics employed. Convalescence is usually protracted by great weakness, or by the occurrence of prolonged suppuration of buboes, or by slow recovery from skin necrosis, or by one or several of the other complications already referred to. As it is believed, and the belief is supported by bacteriological evidence, that a convalescent may cause infection for from four to six weeks after all acute symptoms have disappeared, isolation for at least four weeks after the pyrexia has subsided is advisable, especially in cases of pneumonic plague and in cases with protracted secondary broncho-pneumonia.

Gatacre's Report, p. 69; James' Report on Plague, p. 16.

20,427; 26,962.

Annales de l'Institut Pasteur September 25th, 1900; 25,355; Zeitschrift, f. Hygiene, 1899, p. 405.

T. R. F.

APPENDIX No. III.

MEMORANDUM BY THE PRESIDENT ON THE INFLUENCE OF INSANITARY CONDITIONS UPON THE EXTENSION AND VIRULENCE OF PLAGUE IN INDIA, DISAGREEING WITH CERTAIN OF THE CONCLUSIONS OF THE MAJORITY OF THE COMMISSION.

The Plague in India, 1896, 1897, by R. Nathan, I.C.S., p. 42; Papers relating to Village Sanitation in India, 1888–1895, published by authority of the Government of India; Presidential Address to First Indian Medical Congress, by Surgeon-Colonel R. Harvey, 1895.

1. The opinion is widely entertained that plague forms no exception to other infectious diseases in being fostered and maintained by insanitary conditions. It, therefore, appears of importance to examine the evidence bearing upon this subject, with the view of determining to what extent the progress and virulence of the present Indian epidemic have been influenced by the existing condition of sanitation, and, if they appear to have been injuriously affected, with the view, also, of ascertaining in what directions improvement is mainly suggested and to what extent and by what means it may be effected.

It may at once be stated that the evidence placed before us, as well as personal observations made in India, have rendered it only too evident that the sanitation, both of the urban and of the rural districts of that country, is in an unsatisfactory condition. So generally is this conceded, however, that it is sufficient to illustrate the statement by a few examples relating to places which have been affected with plague.

I.—Examples of Insanitary Condition of Towns, Villages and Houses.

Description of insanitary condition of towns and villages.

Vol. I., Appendix XX., 463.

2. Calcutta is thus described by its Health Officer: "It possesses few advantages except the proximity of the River Hoogly, being flat, low-lying, and alluvial. By making a large number of tanks the level has been somewhat raised in parts, but most of these tanks are so exceeding foul as to come within the category of nuisances. In the native quarters of the town buildings have been run up under little control, so that they are crowded together on the site. Add to this an increasing population, defective system of sewage, and an insufficient establishment of scavengers, and no sanatarian will be surprised that in spite of a considerable expenditure on the part of the town authorities the health of the town has steadily deteriorated." This deterioration is shown by the general death-rate having increased from 28·7 in 1889 to 36·1 in 1897, and the fever death-rate from 8·8 to 14·1 in the same period.

Sanitary Inspection Report on the Calcutta Municipality, October 1898, pp. 3 4.

In the Report of a Sanitary Survey of Calcutta made in 1896, it is stated that, so far as the Committee who made the Survey had observed, there is very considerable overcrowding in every one of the wards. "Other native cities have been reported on as being bad enough, but the metropolis, which should serve as a model, is obviously at least five times as overcrowded as the most overcrowded municipality in Bengal." Many specific examples are given, as that of a house with three living rooms on the ground floor, each measuring 6 × 8 × 8 feet, which are "pitch dark and quite unventilated," while on the first floor there are six living rooms, "of which only the two front rooms are decently ventilated and lighted"; and of a house in which only two of the twelve rooms "have any ventilation, except that of the doorways," the house being occupied by 150 people, although the Committee considered that "there is only room for 40 or 50 people at the outside." Though a large portion of Ward 25 is thinly populated, in the areas properly understood as Watgunge and Kidderpore, there is very great overcrowding both of houses and of people inhabiting them. "This is especially well marked in the part of Kidderpore between Diamond Harbour and Garden Reach Circular Roads, where pucka buildings and bustees exist in such large numbers, and are so crowded and badly arranged as to endanger the public health, if an epidemic, such as plague, should ever break out." The most conspicuous evils to which attention is drawn relate, however, to drainage and conservancy. "The condition of the house drains and 'down-pipes,' which were intended to convey latrine and house and sullage water, were in a deplorable condition. In a large number of cases, the down-pipe was broken at from 5 to 15 feet from the ground, and the water, urine, and liquid sewage from the houses were simply splashing on the ground, fouling the whole gully or lane, and soaking the walls of the houses which, in many cases, were most thickly covered with filth." "In a street in Ward 17 the houses are built almost back to back. It is nearly impossible to squeeze between them; sunlight is so far shut out that,

Do., p. 8.

Do., p. 21 (5).

Do., p. 6.

Do., p. 8.

with broad daylight outside the gully, it is absolutely impossible to do more than to grope your way from one part to another within these tenements; rats run about here in the dark as they would at night; a heavy sickening odour pervades the whole place; walls and floors alike are damp with contamination from liquid sewage which is rotting, and for which there is no escape. . . . Jammed in among these overcrowded huts are clusters of filthy, dilapidated privies, which are fouled beyond description, with their drainage discharging into the little space that is left, and polluting everything." Notwithstanding the improvements which have been effected since this Report was published, or since the commencement of the present Indian epidemic of plague, Members of the Commission had opportunities of observing that these insanitary conditions still largely exist in Calcutta.

In Major H. J. Dyson and Captain J. T. Calvert's Report on the Plague in Bombay p. 8.
it is stated that "The population amounted to 821,764 persons, spread over an area of 22 miles, thus giving an average density of 37,352 to the square mile. Unfortunately the population is not equally distributed, but varies within the widest limits amongst the 32 sections into which the city and island are divided. Thus the density varies from 700 per acre in Kumbharwada to 4·6 to the acre in Sion, whilst an average of 12 sections have no less than 458 persons per acre. In these thickly populated wards so narrow are the streets and so close together are the houses that the latter occupy 85 per cent. of the ground area."

Report on the Outbreak of Bubonic Plague in Bombay, 1896–7, by P. C. H. Snow, Esq., I.C.S., pp. 190, 191.

In one of the most crowded of these areas, Kamathipura, "the level of the subsoil water is the highest in Bombay, and polluted through old reclamations with refuse;" . . . "large areas of Byculla are without drains, and buildings in other portions, where there are no drains, are on such low grounds that they cannot be drained . . . and in Khetwadi, where two large plague hospitals are placed, a large area—more than one-half—has buildings that heavy rains leave standing in sewage and water." On account of its position, the drainage of Bombay is impossible without a large expenditure of money for pumping the sewage from the
low-lying grounds; more than a quarter of the city is without drains, and Malabar 25,741.
Hill, where the finest residences are situated, is destitute of sewers, and possesses
storm-water drains only. "In the drained districts the solid matter is received in 25,750.
baskets or in pans at the bottom of the privies and removed by halalkhores, and 25 54.
the fluid portion flows into the drainage system." In "the districts where house
connexions on the new system have not been carried out liquid matter flows from
an open gali into the street sewers. In districts that have no drains the solid 25,760.
matter is removed to depôts and the liquid matter is received in cesspools." It "is
the most crowded city in India." The "population is concentrated in houses that
are very closely packed and very imperfectly ventilated. There are in some houses 833.
in Bombay over 1,000 persons" (according to others as many as 2,000 or 2,500)
"distributed in rooms, a family, or even more among the outcast population, to 17,289.
each room." "To 9 out of 11 houses in Mody Street in which cases at that Snow's Report,
period occurred there were no gullies on one side of the buildings for either p. 93, para. 295.
ventilation or light." The average mortality in the five years preceding the
outbreak of plague was stated by Dr. Weir to range between 50 per 1,000 in the 883–7.
worst localities, including the residences of by far the greatest part of the population, and 10, 15, and 20 per 1,000 in Malabar Hill and the wealthy suburbs; and there is "an enormous mortality" from phthisis, attributed to dampness and to the bad air in the dwellings.

Report on the Bubonic Plague in Bombay, by Brigadier-General W. F. Gatacre, C.B., p. 208.

Cutch Mandvi, a seaport town of 38,000 inhabitants, is, as described by Lieutenant-Colonel Wilkins, I.M.S., "almost square in shape, and, roughly speaking, covers a square mile; there are high walls of about 20 feet in height, with bastions here and there surrounding the city, and four large gates and some small ones. On proceeding inside the city through one of the gates we come on a dense mass of houses, mostly built of stone and evidently very much overcrowded during ordinary times. The so-called streets are in reality narrow and tortuous lanes, the widest part not being more than 14 feet wide, and most of them very much less than 10 feet wide. The houses are for the most part built of stone, and are usually one storey in height, and nearly all of them enclosed by high walls with gateways leading into the courtyard, which is surrounded by small rooms which are ill-ventilated, gloomy, and dirty, and the lower rooms usually without any plinth, and sometimes below the ground level. The courtyard is generally used as a stable for cows and other animals, and, as it is not the custom to clean these yards, the smell from them is usually very offensive. The habits of the inhabitants are decidedly dirty, the latrines are usually the streets, and it is said it is not considered etiquette on the part of a stranger to enter the city before 8 a.m., up to which hour the inhabitants use the streets for purposes of nature. There are a few latrines attached to the walls of the city on its western side, but these are hardly ever cleaned, and the consequence of this free and easy method of sanitation may well be imagined, and it is not to be wondered at that once the plague bacillus found a haven of rest here it flourished to a great degree, for it 13,349-55. had all its requirements, *viz.*, filth, darkness, dense overcrowding, and no ventilation. The streets have no drains." A great many cattle are also kept inside the houses.

Referring to Karachi, Lieutenant Anderson, I.S.C., stated: "In that portion of the Market Quarter in which the disease was most severe, the houses are mostly very old and built of mud plastered over a framework of sticks. Latterly, stone fronts have been built to some of them, but the house behind its imposing exterior remains the same as before. The foundations of these houses are saturated with sewage and filth of every description. There is generally a cesspool below the 22,649. house which has not been emptied since the house was built, and the neighbourhood of which is honeycombed with rat holes, and which is probably situated close to a well from which water is drawn for washing if not for drinking purposes. This evil was aggravated by the narrowness of the streets and the scarcity of windows. The municipality have followed a fatal policy of allowing householders to encroach upon the streets and selling them strips of land in front of their houses until it has been absolutely impossible to sell any more. Overcrowding, moreover, exists to a terrible extent. . . . It is, therefore, not surprising that the plague was so severe in this quarter."

Report on Plague in the Mysore State by Madhava Rao, 1898-99, p. 4.

The Plague Commissioner for the Mysore State has thus described the condition of Bangalore City: "Established three and a half centuries ago, before the laws of hygiene and sanitation were understood, it has been allowed to go unrestricted, according to the exigencies of the moment and confined practically to its original limits. As a result, it has become terribly overcrowded, and since sanitation was unknown until the introduction of the municipal regulations, and as even then there were localities so built over as to defy all attempts of the sanitary authorities at cleansing them, its soil had become saturated with the impurities of generations. It was here, while the work of relieving this congestion and of improving this sanitation was still far from completion, that plague broke out, and it was within this area that it most persistently continued its ravages." When asked what was 3250. the sanitary condition of the affected localities in the city, he replied: "Sanitation was very defective in all the localities."

2308-9. Major Hardy, I.S.C., Chief Superintendent of plague operations in Dharwar City, described the houses as being chiefly small and tile-roofed and without windows; the water supply as being obtained from two public wells, one at each end of the city, and from many private wells in the compounds of houses; the privy accommodation as consisting of five latrines at the south end of the city, sufficient for only 600 of the 2314-6. 35,000 inhabitants, and of numerous pit privies, close to and even inside of dwellings, which are 15 feet deep and from 2 to 2½ feet wide, and as they are never emptied they are often full to the top and very offensive; and the drains as being 2317-22. open gullies in the streets, lined with stones but not cemented, from which the contents escape and foul the soil.

Lieut.-Colonel Bartholomeusz, I.M.S., stated that the sanitation of Ahmedabad is very unsatisfactory, especially "with regard to want of drainage, narrowness of 13,957. streets, overcrowding of the houses, and removal of night soil. The water supply is very good."

Describing the sanitary measures adopted during the first plague outbreak at Surat, a town of 100,000 inhabitants, Mr. Moore, I.C.S., mentioned that several thousand pit 24,459. privies were closed, which were in the ground floor of the houses either inside or just outside the house wall, very often in close proximity to wells from which water was taken for drinking, and which, in some instances, had not been cleared within the memory of the present owner.

In the Baroda State "the dwellings of the ordinary people are of a poor description. 15,193. They are damp, ill-ventilated, and constructed without regard to sanitary precautions. The population being mainly agricultural, houses and streets are crowded together in small areas. People and cattle dwell under the same roof, and the soil is saturated with human and animal excreta. The pollution of the soil, air, and water is common."

Description of insanitary condition of dwelling-houses.

3. In the evidence laid before us and in the Reports on plague which we have had an opportunity of considering, the faults of general sanitation, however, occupy a subordinate place to those specially relating to the insanitary state of the dwellings and the nature of the conditions existing within them.

A short report on the plague in Bombay, and the measures taken to suppress it, 1897, pp. 8, 9.

In their report on the plague in Bombay, Major H. J. Dyson, I.M.S., Sanitary Commissioner, and Captain J. T. Calvert, I.M.S., thus describe the chawls in which a large portion of the inhabitants of Bombay reside: "On the ground floor is a narrow central passage about three feet wide with mud floor running the entire length of the building. At one end of this passage is the opening into the street; at the other is a latrine common to the floor on the one side, and the fresh-water cistern on the other. From this central passage doors open on each side into small cubicles. The floor of the cubicles is of mud, the partitions of wood or of small sticks plastered with mud. There is no window, no chimney, no light or ventilation, save such as penetrate through the doorway from the dimly lighted central passage. In the bright light of an Indian sun at midday, so dark are they that it is impossible to distinguish the presence of a second person in the room, and small oil lamps have to be used when cooking has to be done. The cubicles average about 10 feet square and 8 to 10 feet high. The number of persons who sleep in them is usually limited by the floor space, for on a rainy night, sleeping out of doors being impossible, they lie like sardines in a tin. The expression 'usually limited' is used advisedly, for in some cubicles a small pigeon loft about 6 feet from the ground has been built, access to which is obtained by means of a bamboo ladder, and here in a low garret sleeping accommodation is found for still more. Imagine five more storeys of this description connected by narrow staircases, and you have a
picture of an average Bombay chawl." It may be added to this, as a result of personal 847.
observations, that the central passages of many of the chawls that were visited were nearly
dark and were filthy with moist mud and human excrement; and that, as the above
description implies, the chief, and sometimes the sole, means for the admission of air into
the small dwellings or cubicles was by these passages. The Medical Officer of Health,
Dr. Weir, gave the following further information: "You were going to say something
more about the ventilation?—The difficulty is with regard to ventilation at night.
There is a front door which closes the central passage. Where there is not over the
front door an open grating, the ventilation (except in cases where there happens to be
what is called a chauk over the staircase) is from a little space at the back where
the privy is." "That opens outside of the house into what?—That opens outside 848.
the house into what is called the sweeper's gali, a small gali." "Which is not very 849.
sweet?—The galis in many parts of the town are good. The difficulty, as you
observed yesterday, is in regard to the pavement permitting percolation, fluid
percolating down between the stones when the ground is worn away. The surfaces
of the galis are clean." "The old galis are very irregular?—Yes." "What light 850.
is there in houses of this kind?—The light is extremely defective. Even in the 851.
case of a better house than that I have described the light is very dim indeed."
"What does it proceed from?—The light would proceed from a door communicating 852.
with the central passage and from a window communicating with a side gali outside,
a gali 1 foot 6 inches to 3 feet wide." "One of those narrow galis I saw?—Yes." 853.
"The outside wall of this gali being the wall of another high house?—Yes." "Is 854.
there much filth found in these places?—Over these galis there is a constant passage 856.
of fluid carrying excreta containing organic matter. There is a continual throwing
out from the windows of solid matter on to the gali; in fact, the galis are the
ashpits of the houses in Bombay. There are no ashpits here." He also stated
that 70 per cent. of the buildings in the Kamathipura Ward, having a population 972.
of nearly 30,000, and not less than 80 per cent. in the adjoining ward, are in a 974.
similarly insanitary condition.

Surgeon-General Cleghorn, late Medical Adviser and Sanitary Commissioner with
the Government of India, stated that the houses in Bombay are "worse than any place
I had seen, owing to the enormous number of people who lived under the same roof.
I have never seen anything like such overcrowding. In a place 6 feet by 12 feet I 26,644.
have seen the floors covered by people lying down, and, in addition, beds hanging
from the roofs on which other people slept at night. There was absolutely not one
ray of light, or any means of getting air to these rooms. We had to strike a
match to see the opposite walls because it was so dark, and that was in the middle
of the day." "I have never seen anything like such overcrowding in rooms
absolutely without any means of ventilation." Where windows existed, they were 26,645.

generally small, and as they opened on to the wall of the next house, from which they
26,646–8. were separated by a narrow alley, "in order to secure privacy, all the windows were
covered up with clothing, &c." The separating alley was chiefly occupied by an open
sewer which rendered the air foul.

Snow's Report, p. 110 para. 377. In this city, during an inspection made in the first half of 1897 by one medical
official, 1,903 tenements were found to be in part or entirely unfit for human habitation,
chiefly because of the absence of means for admitting sufficient air and light.

The condition of overcrowding in the houses of the labouring population of Bombay
was thus graphically described by Dr. Blaney, who had been a medical practitioner
in that city for upwards of 50 years. "If they go into their rooms their feet and
heads are together, and the whole atmosphere is vitiated, and, even supposing
17,711. there was no epidemic, they incur every possible risk because of overcrowding in
sleeping rooms." The amount of this overcrowding is even more vividly realised in
p. 188. the statement in Snow's Report, that in one of the wards the concentration of
population is 469 persons to the acre, whereas the extreme in London, before the
recent metropolitan improvements had been inaugurated, was 222. Elsewhere in that
p. 29. Report it is stated: "A lurid light has been thrown upon certain sanitary shortcomings
of Bombay by the present epidemic. The principal of these may be found in the
density of the population and overcrowding in chawls and houses."

22,810. In Belgaum, the usual house is narrow and deep, with a door at each narrow end.
There are three rooms, each opening into the other, and, while the two end rooms
have doors, the middle room is quite dark and has no opening to the outside.

13,786–8. The poorer houses in Nasik, and the great majority of the houses in Malegaon, are
one-roomed, overcrowded, and without any window, and the floors are of earth and
cow-dunged, if the people were well-to-do. "The door lets in all the light and air
16,980–4. there is, and it is closed at night." A one-roomed house, about 10 feet or 12 feet
square, would contain a family consisting of the father, mother, and two or three
children, or "there would probably be about six or eight people living in it."

15,937–8. In the localities in the town of Surat where plague was most prevalent, the houses
have sometimes no ventilating openings except the doorway. The houses of the Golas,
16,107–8. who suffered severely, "were overcrowded, ill-ventilated, insanitary, almost without
light and air."

19,690–3. In the villages of the Thana District, which suffered severely from plague, most of
the people live in very poor two or three chambered houses, without any windows,
the door or doors being the only outside openings.

Major Hyde-Cates, I.S.C., described the houses in the small town of Salaya, near
13,355. Cutch Mandvi, as being exceptionally dark. "There are no windows at all except in
the outer room, and there are three or four rooms behind that which are, as a rule,
pitch dark, with no windows or ventilation of any sort, except from the door of
the front room, which opens on to the street."

According to the Plague Commissioner for the Mysore State, plague cases in
3251–7. Bangalore occurred chiefly in the prevailing mud houses, which had one or two
rooms only, were ventilated by a hole in the roof of the cooking place in each house,
were badly lighted, and had a small window or windows on one side generally, but
3258. owing "to being close to other houses there was no free scope of air." "In some
cases, rooms only 6 × 6 were occupied by a family consisting of four members."
Report on plague in the Mysore State, 1898–9, by Madhava Rao, Chief Plague Commissioner, p. 58, para. 232. In the villages of the Tumkur District in this State, the virulence of the outbreak is
explained by the practice "with all classes of people to tie their cattle in their houses.
The excreta of these animals is allowed to soak into the floor, which forms a
good breeding ground for germs"; and the number of victims in the same family
was considerably larger in the villages than in the towns.

In Ahmednagar, the mud houses, in which nearly all the plague cases occurred,
24,275. have "very few openings for ventilation. If there are any, they are very small. They
are not suited to bringing in the rays of the sun direct."

In Karachi, the houses are built of sun-burnt bricks, have generally about three
11,081–6. storeys, with very small rooms, and are occupied usually by one family. In the
opinion of Mr. Giles, Acting Commissioner for Sind, they are overcrowded, very
badly lighted—"in fact, when you get inside you can see really nothing at all," and
many of the rooms have no openings except the doorway. In the Garden Quarter,
where many cases of plague occurred, the sun's rays cannot enter the houses, as
12,456–63. there are inner rooms and downstairs rooms "where the sun could not possibly get."

At Kiamari, the houses "had a dead wall through the middle, and there were rooms on each side. There was no possibility of any free passage of air. When you 11,971. went inside in the early morning, the smell was very bad as a rule. . . . . Directly we get cases they seem to spread like wildfire."

In justification of the unroofing of houses in the Satara District, Lieutenant Steen, I.S.C., stated: "A good many of the houses I have had to deal with probably never 22,734. had any ventilation for years. Mud-roofed houses, especially, are so constructed that it is almost impossible to ventilate the interior."

When examined by the Commission, Captain Meyer, I.M.S., expressed the opinion 20,144. that the houses in Hubli and the railway chawls, where the first cases of plague 20,207. occurred, were remarkable for their bad ventilation. "They were so very dark even for an Indian city. The windows were very small and usually sealed up. There were a great many verandahs in the houses which prevented the circulation of air. 20,213. The internal ventilation of the houses was extremely defective. In other respects the sanitary conditions of the houses in Hubli were excellent for an Indian city."

The Acting Commissioner for the Southern Division of Bombay Presidency (Mr. Cappel) gave evidence regarding the towns and villages of the Dharwar District to this effect: "In this part of the country the houses are of brick; the inner 1711. rooms of all the houses are absolutely dark, so much so that you cannot see your way. When the first case occurred here, in Dharwar, I went down to the town, and they said there were some people who were sick in a certain house. I went in, and fell over a dead body, and, getting a light, we discovered another. There are no windows, no light, and no ventilation." Speaking of the villages in this District, the Deputy District Collector stated: "Generally the houses of the agriculturists in villages are very filthy, ill-ventilated, and dark. The agriculturists 23,518. tether their cattle inside their houses and allow cow-dung and manure to accumulate in the back yards. They never keep the place where cattle are tethered clean. Owing to want of ventilation and light the houses stink so badly that one who is accustomed to live in purer atmosphere can hardly bear the smell." In nearly all the houses in the Dharwar and Hubli Districts the floors are formed of mud 23,250. and cow-dung, and the walls of mud or mud mixed with lime.

Captain James, I.M.S., described the general type of dwellings in the plague-affected villages of Jullundur as constructed "of unbaked bricks, mud houses, usually square or rectangular, with flat roofs. They are very simple houses, many of them not 10,370. containing windows, and the only means of ventilation and light is the doorway."

Among the many interesting facts brought before us regarding the conditions prevailing in the villages of Kumaun and Garhwal in the North West Provinces, where plague Vol. II., Appendix XXV., p. 360, paras. 251, 6176. has so frequently occurred during the last 60 or 70 years as to have acquired an endemic persistence, none has been more conspicuous than the insanitation of the dwelling-houses. Thus, Surgeon-General Richardson described the houses when inspected by him in 1876 as "generally dark and ill-ventilated. One had almost to enter on hands and knees, and could scarcely stand upright after entering. These rooms, or rather garrets, were crowded with baskets of grain, baskets of wool, and goatskin bags of flour, wooden vessels filled with ghi and other domestic belongings; 26,611. usually the cattle occupied the ground floor underneath these garrets or lofts." The houses were generally roofed with coarse slabs, and the ventilation found its way through these slabs. "There were bits of holes now and again, in 26,631. which they stuffed something, as a rule. They were very ill-ventilated and dark places." Surgeon-General Planck describes the local conditions of two plague-affected villages in 1877, as follows:—"The well-built houses were seen to be double-storied, Vol. II., Appendix XXV., p. 338, para. 111. one room below and one above; close unventilated tenements. The lower room used only as a cow-house, the upper room for family occupation. In the lower room, about five feet high, it had been customary to lodge from four to eight head of cattle or goats at night, and, indeed, in some instances, as many as the room had standing place for; the only opening being the small doorway of entrance, tight closed and barred at night. These rooms were seen to be littered for about a foot in depth with a little decaying straw and much manure, moistened with the fluid excretion of cattle, and the entrance way on each side and the stone platform facing the lower storey, were piled with heaps of manure, which had been drawn out of the lower room as necessity required, and there left for eventual removal to the land in the ploughing season. The upper room was noticed to be roughly divided by wooden slabs into a front and back portion, the former used as the family sleeping place, the latter as a granary; the doorway, in some instances, a round hole in the front, and a small round hole for the exit of smoke through the roof of the house, all commonly closed at night, being the only openings. The floor was made of thin wood, with pretty numerous cracks, so that the warmth generated by the cattle below could reach to the sleeping people above." The suggestiveness of this description derives additional force from the circumstance that "as regards the site generally and the precincts of the villages, nothing of insanitary aspect could be seen . . . the surrounding conditions were clear, clean surface, bright flowing water, sweet air everywhere, all of the unwholesomeness of the site was gathered within and immediately around the habitations." Cháni, another plague-infected village, is situated on the sloping brow of a hill which stands out from the great mountain behind it, and its high position provides for perfect drainage. The lower storeys of the houses, however, were found to be "filthy, as a rule, owing to their utilisation as cow-sheds, the upper storeys without ventilation, close smelling and unwholesome." During a recent visit to the district made under our direction, Lieutenants Walton and Douglas, I.M.S., found that the condition of the houses was much the same as described above, the ground floors being still used to stall cattle, and the windows of the houses being still "very small or absent, and the rooms very dark and quite unventilated." The surroundings of the houses were, however, so far improved that manure was not accumulated near the houses.

Vol. II., Appendix XXV., p. 338, para. 112.

Vol. II., Appendix XXV., p. 346, paras. 158, 160.

Vol. II., Appendix XXV.(1), p. 366.

Difficulties in effecting sanitary improvements in India.

4. Before concluding this abstract of some of the evidence relating to conditions of sanitation in India, it is desirable to allude to the great difficulties in the establishment of conditions favourable to public health in that country. To some extent these are stated in the following quotation from General Gatacre's Report on the Bubonic Plague in Bombay: "It must be remembered that in all large Oriental cities a very large proportion of the population are very poor and cannot afford to pay the rent of a really sanitary building. They therefore are forced to live in miserable shanties, dark, low, small, and built on insanitary sites without plinth, added to which, with a view to bringing the cost of this habitation to the lowest point, 16 or 20 persons will sleep, eat, and cook in a place hardly sufficient for the requirements of four."

p. 232.

Much sanitary work has been accomplished.

It is apparent from the Evidence that a considerable amount of effective sanitary work has been overtaken in several of the cities and larger towns of India during the last 20 years, especially in the direction of improving the water supply and introducing sewerage systems. It is to be regretted that, owing no doubt to financial difficulties, the beneficial effects of some of this work has been lessened by its incompleteness, as, for instance, where an abundant supply of water has been introduced, while no proper drainage has been provided. The work remaining to be accomplished is, however, gigantic; and when plague was introduced into India in 1896, the prevailing insanitary conditions were eminently favourable for the diffusion of any infectious disease whose infectivity and virulence are enhanced by insanitary conditions.

7840, 15,932–5; 23,323; II. 379–80; 23,363; Snow's Report, p. 29.

II.—Opinions that the Spread of Plague is due to General Insanitary Conditions.

5. That plague is such a disease has been widely and influentially maintained. The present Director-General of the Indian Medical Service and Sanitary Commissioner with the Government expressed this view in the following words: "Plague is a disease propagated by a specific germ which springs from a pre-existing germ and cannot originate *de novo*. This germ is the seed of the disease, and as seed cannot grow without proper soil, so this plague seed cannot flourish unless it finds an environment suited to it, and that environment is made by all these insanitary conditions. It is a disease of filth, a disease of dirt, and a disease of poverty. The whole history of plague, so far as we know it, shows that to a great extent."

7836.

21,323.

To the same effect was the evidence of Lieut.-Colonel Fawcett, R.A.M.C.: "It is unfortunately an axiom that plague in its epidemic form is only to be found where dirt, darkness, and overcrowding prevail. In a word, in those places where sanitation is unknown, impossible, or neglected. Most fortunately, it cannot be carried to any appreciable extent by water or air, and the bacillus which causes it, though capable of multiplication with extraordinary rapidity in a suitable nidus, has neither power of resistance, locomotion, or spore formation, and dies at once in the light of day."

Vol. I., Appendix VII. p. 351.

According to Captain H. Dempster Mason, R.A.M.C., the conditions chiefly affecting the propagation of plague are: "a warm and humid atmosphere, the people living on marshy soil on the sea-coast and creeks; low, badly ventilated, and overcrowded houses; great accumulation of putrefying animal and vegetable matter in the vicinity of the dwellings; the most revolting filthiness in personal habits; and the whole cities little better than one large latrine, in such an insanitary state that it requires to be seen to be believed." 2923.

Lieut.-Colonel Dobson, I.M.S., considers "that exposure to conditions such as the following are necessary to develop the disease, *e.g.*, overcrowding, destitution, deficient cubic space, ventilation and sunlight, and a filthy and general insanitary condition of person, clothing, habitation, and its surroundings."

Dr. Clemow considered that the spread of plague is favoured by insanitary conditions, because "the majority of cases in Calcutta were among the poorer classes of natives living in dirty and unhygienic places, and the early cases occurred in an insanitary area, and in houses and bustees which abound in sanitary deficiencies. The outbreak in Roop Chand Roy's Street, the most concentrated outbreak in Calcutta, occurred in one of the most insanitary bustees." 7180.

"The predisposing circumstances," according to Mr. D. A. Choksi, Chief Plague Officer in Bangalore, "are overcrowding, ill-ventilating, ill-drainage, and bad lighting." 3386. Mr. K. B. Jadhav's experience at Baroda led him to conclude that the propagation of plague is chiefly effected "by very bad water, and damp in the houses, filth, and no conservancy arrangements"; 15,151. and Mr. Patwardhan found that, in Poona, "most of the houses affected were either old buildings with moist floors, or ill-ventilated and with insanitary surroundings." 21,548.

Necessity for separating insanitary conditions outside from those inside of dwellings.

6. It is indicated, by the opinions which have now been quoted, that insanitary conditions in general are frequently held to be accountable for the extension of plague. The association of the disease with general uncleanliness has even been emphasised by a repetition of the old statement that it is "a filth disease." Much of the evidence placed before us, however, indicates that a distinction may properly be drawn between the fostering influences exerted upon plague by conditions existing outside as contrasted with those existing inside dwellings, between the effects of sewage and excrement pollution of the open ground in the neighbourhood of houses and the insanitary conditions which are present in the interior of houses. (7836, James' Report, p. 22.) It has not been found, for example, that plague has prevailed largely among people who from occupation or habit came specially into proximity or even contact with the materials of outside pollution. (Jadhav's Report, p. 15.) The scavengers of Bombay, "although working with naked feet and hands in the filth from houses where cases had occurred, were the least affected of all classes of the poor." (Minutes of Evidence, Vol. I., Appendix XIV., p. 378.) The strenuous efforts made at large expense in Bombay and elsewhere to restrict the advance of plague by cleaning the streets and flushing the drains with solutions of disinfectant substances had no appreciable effect upon its advance; (Snow's Report, p. 175, para. 626.) and "anything that was done outside of the buildings in which cases occurred had little influence upon its extension." (Gatacre's Report, p. 185.) Although the extensive cleaning operations of the drains, streets, and houses of Poona had, in the plague outbreak of 1897, rendered that city "cleaner than it ever had been within the memory of [illegible]ng man," each subsequent outbreak was more extensive and virulent than the outbreaks which had preceded it. (Snow's Report, p. 175, para. 62 Gatacre's Repo p.190, 8707.) People who slept in the open air, on ground sodden with filth, were rarely affected; "people living in open spaces, even in filthy surroundings, escape infection"; 19,515 and it was found that few cases occurred among "those who work out in the docks during the day and keep out in the air at night also, and only [illegible] enough time in their rooms to take their food." 17, It has been shown "that people living on the roadside had better chances of recovery, and that a larger proportion of t survived than people living in dwellings." The outbreaks in Bombay, and i places where seasonal variations are marked, have notably declined in the hot and increased in the cold and wet weather, and this has frequently been at the chawls and houses being rendered unhealthy in the latter season by o the inmates being unable to work outside and to sleep at night in the str ground, usually filthy and sewage-sodden, "as large numbers are acc during the warmer months." Even when plague had in the hot [illegible] n into a large town and had infected the rats there, no further exten[illegible] o weather became cold, because during the hot season the peo[illegible] p night, "were probably out in the air all day," and "scarcely [illegible] ie houses at all." For this reason, also, it was believed that [illegible] n became dormant during the hot weather, and resumed its [illegible] ic again caused people to sleep in the much vitiated atmosphere of [illegible] h opportunities for observing the conditions favourable to the [illegible] ior led Lieut.-Colonel Weir, I.M.S., to arrive at the definite con[illegible] tl associating this disease with dirt in the sense of refuse is [illegible] w "the common view of the pythogenic nature of the disease m[illegible] m

III.—OPINIONS THAT THE SPREAD AND VIRULENCE OF THE PLAGUE ARE CHIEFLY DUE TO INSANITARY CONDITIONS WITHIN DWELLINGS.

7. The great mass of the evidence bearing on this subject that has been laid before us is, indeed, in support of this contention, for it is to the effect that, in so far as insanitary conditions operate, the conditions inside rather than those outside of dwellings are the main causes of the propagation and virulence of the disease.

Surgeon-General Cleghorn, lately Director-General and Sanitary Commissioner with the Government of India, pointed out that plague had chiefly appeared in Bombay 26,638. "in the worst houses, and that the better ones, including the small hotels situated in the infected quarters had practically escaped." The latter, however, were well provided with air and light, having been built according to European ideas, and there 26,672-4. was no overcrowding in them. He also remarked that he "had of course a considerable experience of the conditions under which the poorer classes in other parts of India 26,638. lived," but he "had never seen anything so bad as existed in the chawls of Bombay."

The present Director-General and Sanitary Commissioner with the Government of India, Surgeon-General Harvey, stated that the sanitary improvements specially 8066. required to prevent plague are mostly within the houses. They are "generally damp, they have an absorbent mud floor and very little light, and no ventilation, as a rule, except what they get through the tiles of the roofs."

Report on the Outbreak of Bubonic Plague in Bombay, 1896-7, by P. C. H. Snow, I.C.S., p. 148.

One of the Medical Officers in Bombay thus describes the condition of the houses in Kamathipura District, in which plague was specially virulent: "I have gone through all the houses, and almost all the rooms on the ground floor and most of the houses are not fit for human habitation, owing to want of light and ventilation."

Snow's Report, pp. 147-148.

Lieut.-Colonel Weir was of opinion that "the incidence of the disease is most influenced by the ventilation of buildings. . . . In localities, the worst ventilated and the most densely crowded with buildings, the incidence of the disease was the greatest. As with localities, so it was with buildings. While in open houses it was difficult to contract the disease, in bad ones it was difficult to escape it."

Having pointed out that plague has occurred chiefly in insanitary and overcrowded 17,692. houses, Dr. Blaney, in reply to the question—"By insanitary dwellings, or insanitary conditions, what do you include besides overcrowding?" answered: "Darkness, dimness, and want of ventilation. They are rookeries in lots of cases. In many of the outlying districts a man can hardly stand upright in his house. They are not fit for human habitation at all."

05. Professor Gokhale, a volunteer plague officer at Poona, stated: "Generally I found that houses that were damp, dark, and ill-ventilated were most exposed to the 5. attack"; while Mr. Kabraji, I.C.S., the Acting Collector at Kaira, observed that "by far the largest majority of plague cases, if not all, occur when the sleeping rooms are badly or insufficiently ventilated or lighted."

The following evidence was given by Captain Bingley, I.S.C., who had charge of one of the district wards in Bombay : "Do the habitations in your district vary much
heir characteristics ?—Yes, they are very varying." "What sort of variations ?
instance, in Fanas Wadi District, which is inhabited chiefly by Parsees, there
or five-storeyed houses; the rooms are large, and not, as a rule, overcrowded;
Talao District is in parts very poor, and the overcrowding is considerable;
rwada and Khara Talao Districts are occupied chiefly by the labouring
of the houses being lodging-houses, and the overcrowding is very
houses there are of a very inferior type. There are no plinths at all,
d floors are below the level of the street. The rooms are very dark,
een subdivided by partitions, so as to make one room into four or five.
ns have thus no windows, and no light or air. In fact, in many
l have to use lamps night and day." "Did you find any relationship
umber of plague cases and the nature of the habitations ?—Yes."
relationship ?—As a general rule, where the houses were very bad,
bad." "Have you seen many cases of plague in the best of the
"Some ?—Yes, but they were comparatively few."

ieut.-Colonel Weir, the village of Parel "has been drained, but no con-
n made between the sewers and the houses, and the sewage either flows
rface of the narrow lanes or roads into the soil. This village is in an
insanitary condition, and has been a hotbed of fever for many years."

It contains a number of very good and well-ventilated houses, and also "many overcrowded hovels of the most insanitary class, situated in sewage-sodden soil and abutting on narrow lanes, and it was in these houses that the disease chiefly raged." Gatacre's Report, pp. 190, 191. Snow's Report, pp. 108-11.

The fishing village of Worli, at the north-west of Bombay Island, where 124 cases of plague with 104 deaths occurred during December 1897, is situated on the slope of a hill gently descending to the ocean on one side, and to the Mahim shore on the other. "Although in this lovely position," . . . "it enclosed groups of dwellings into which the rays of the sun never entered, nor the pure sea-breeze." Snow's Report, p. 158. These dwellings are, for the most part, huts which are closely packed together; and Lieut.-Colonel Weir has reported that "most of the cases occurred in the centre of the village, in the darkest of the huts."

Major Evans, I.M.S., Resident Medical Officer to the Medical College Hospital, Calcutta, stated that the majority of the plague cases admitted into the hospital came from a very populous district, in which overcrowding during the night is common in 6861. the native huts and houses. "It is no uncommon sight to see the floor of a room covered with sleeping men lying in close proximity."

The Plague Commissioner for the Mysore State considers that "simple momentary or occasional contact with infected people or their clothes does not seem to have had the effect of giving infection. To catch the disease, there should apparently be close and continued contact, especially sleeping in the same house and breathing the vitiated atmosphere of the room in which plague patients are kept." Madhava Rao's Report on Plague in the Mysore State, p. 36, para. 121. He adds that "the Deputy Commissioner thinks that it is abundantly clear that the dirtier and worse ventilated the dwelling, the greater the liability of the occupants to catch and succumb to plague."

Referring to Mysore City, the Health Officer reports that "the incidence of the disease was greatest in localities which were worst ventilated and most densely Do., pp. 36-37. crowded with buildings; as it was with localities, so it was with buildings. Dark, damp, ill-drained and soil-polluted buildings suffered most. In the newer portions of the town where the houses are of a better type, better ventilated, with open spaces in front and behind them, and where overcrowding exists in only a very slight degree, and where sanitation generally is better, cases of plague were few and far between, and the spread of infection was very limited." . . . "As with the spread, so with the virulence of the disease, for in highly congested, badly conserved, ill-drained portions of the town, the disease was more virulent than in the less overcrowded, better conserved, and fairly well-drained parts."

In Mr. Giles's opinion, "There was not the faintest doubt that the ill-ventilated houses where the people were crowded got the plague far the worst; it was quite 11,228. apparent." He considered that the extent and virulence of the disease chiefly depended upon "dirt and overcrowding and want of ventilation," and of these he 11,281. put want of ventilation first.

Lieut.-Col. Nariman, I.M.S., was asked, "Are the houses generally furnished with ventilation openings of some kind in the worst localities of Surat?—No, except the 15,937-8. entrance. There is sometimes no ventilation in the worst localities." "In which locality was plague most prevalent, the better or worse?—The worst."

Mr. Maynard, M.R.C.S., who had a large experience of plague at Nasik, was of opinion "that the chief cause of the spread is overcrowding, the effects of which are 14,716. accentuated by the habit the people have in cold weather of shutting up every aperture in the rooms and crowding into small rooms."

Referring to the dormancy, during the months of May and June 1898, of the plague outbreak at Ankleshwar, Assistant Surgeon Petigara stated that it was probably accounted for by the habit of the native people to sleep and lie outside and not 14,386-8. indoors when the weather is hot. They were thus, he explained, exposed to a pure and dry air unlike that in their houses "where the atmosphere is much vitiated." He considered that the most favourable conditions for the extension of plague were the want of ventilation, overcrowding, and the uncleanliness of the interior of the houses.

Captain C. H. James, I.M.S., expressed the opinion that "light and air seem to be 10,377. inimical to the spread of plague, while dark and badly ventilated places are conducive to it."

The Chairman of the Plague Committee of Ahmednagar, who was also Vice-President of the Municipality, was "fully convinced that plague sticks most and does greatest mischief in dark, ill-ventilated, and dirty houses and localities, and can be stamped out of a sanitary house much easier and quicker," and that people living in the open 24,363. escape being attacked by plague.

Lieut. Law, who had been employed in plague operations in Karachi and Kiamari, summarises his experience in these words: "To sum up from such experience as I had, it seems that the chief enemies of the plague are fresh air, sweetness, and light; that in itself it is essentially a filth disease, and will, *ceteris paribus*, be much more likely to attack those who live in insanitary, unclean, and ill-ventilated abodes than those who have some acquaintance with and pay some reverence to the laws of hygiene." 12,018.

The fishing villages of Baba, Bolit, and Shamspir, on the western side of the harbour of Karachi, remained free from outbreaks, although cases of plague had been imported into two of them, and although the inhabitants of the three villages constantly went in boats to Karachi and to Kadda, to sell fish, at a time when there was plague in both places. The immunity of these villages was attributed by Captain Jenney, I.M.S., to the people leading "a very open-air kind of life," and living in huts which, although of a very poor and inferior description, were made of matting, freely permeable by air, and "were not particularly overcrowded." 12,278-86.

The following opinion was given by Captain L. F. Childe, I.M.S., Principal Physician to the Jamsetjee Hospital, Bombay. "The infectiousness of plague seems to depend mostly upon the surroundings of the patient. I think, in a small room, crowded with many people, and in insanitary conditions the infectious power is high; in a well-ventilated house or a hospital the infectiousness is very slight indeed." 1439.

Speaking of Mahamari or Gola-rog, the endemic plague of Kumaun and Garhwal, Lieut.-Colonel Thomson, C.I.E., I.M.S., said that it "generally breaks out in the cold weather, when the people are huddled together in small rooms with practically no ventilation, as doors and windows are religiously closed to keep out the cold. I may mention here that very often for days together the people are snowed up, and sometimes even for weeks at a time, and on such occasions it is almost impossible to conceive anything more filthy than the places where they live, not only the rooms themselves, but also the immediate vicinity of the houses." 8827. Surgeon-General Planck, from his local study of the disease, has arrived at the conclusion that "the specific poison of the disease is most potent for mischief in the house in which a case of the disease has occurred," while, "on the other hand, the danger of infection appears to be lessened, if at all existent, in the open air." Vol. II., Appendix XXV., p. 362, para. 261. In his opinion, the most important predisposing cause is "a vitiated atmosphere in and around the habitations," the chief sources of which at Kumaun and Garhwal were, he thought, the gases produced from unripe grain stored in the sleeping apartments, and the exhalations from the manure which rise into those apartments from the chamber on the ground floor in which cattle are housed. Vol. II., Appendix XXV., p. 360, para. 252. He considers that the only reliable method of prevention is an improved sanitary management of the houses and homesteads throughout the country. He also draws attention to the circumstance that improvement in this direction was effected on several occasions with good results, and that when lapses afterwards occurred plague resumed its active existence. Vol. II., Appendix XXV., p. 361, para. 256. It is interesting to note that the improvements referred to were produced by the enforcement of the Mahamari Rules, which not only prohibit accumulations of filth near dwellings and the housing of cattle within them, but also require that every room shall have a window at least 2 feet × 2 feet communicating directly with the open air "for purposes of ventilation," and that the inhabitants of a house which contains more than one room shall "distribute themselves between the different rooms at night, so far as possible to diminish the number sleeping in each room." A repromulgation of these rules in 1894 is introduced by the statement that the observance of them had formerly "entirely stamped out" plague. Vol. II., Appendix XXVI., p. 377.

The predisposing effect on plague of insufficient ventilation is likewise illustrated by the history of Sadr Bazar at Satara, during the first two outbreaks of plague in that city. This bazar has a population of 2,325, and there was constant communication between its inhabitants and those of the city, which is a mile distant. During the first outbreak, and while the inhabitants remained yet unaffected, "the houses were unroofed in strips, to let in sun and air, and therefore they were well ventilated. That was not done this year" (in the second outbreak), "and the Sadr Bazar has had an epidemic," which is characterised as a severe one. 22,273. In Satara, "the districts which were exempt last year were compulsorily ventilated by unroofing the houses by strips at a time, and holes being knocked into the walls before plague came." 22,274.

It may be added that the difficulty of extension of plague, even when of the pneumonic type, in fresh air and light, has been further illustrated by the experience in the two closely adjoining villages of Siddhakati and Abhoynil, in the Backergunge 7331-406.

district of Eastern Bengal. The entrance into one of the villages of a plague-infected person from Calcutta was followed within 20 days by 11 cases of pneumonic
plague, all of which terminated in death. One of the six infected houses was "a 7343-5.
superior masonry house," and it was not evacuated; but the contacts from the other five infected houses were transferred from their thatched and presumably badly ventilated huts to several boats on an adjoining sheet of water, and no further cases occurred among them or in the villages. This result is attributed by Mr. Justice, M.B., to the removal of the contacts from the infected houses to the fresh air.

In the summary of the views of the Medical Officers employed in Bombay by the Plague Committee, contained in General Gatacre's Report on the Bubonic Plague in
Bombay, it is stated: "There is now no doubt that it is criminal to allow a plague p. 142.
patient to remain in a close, ill-ventilated, confined room, which is sure to be to his disadvantage as well as a danger to others, and all classes of Indians are well aware of this from their personal experience during the epidemic."

8. It is manifest from the above that there exists a strong conviction among those who have had the best opportunities for forming an opinion that the propagation and virulence of plague are chiefly affected by conditions prevailing within dwellings, rather than outside of them, and especially by insufficient ventilation and light, overcrowding, dampness, a polluted atmosphere, and, to a less extent, uncleanliness.

This conviction has been strengthened and supported by many of the incidents which marked the course of the epidemic and occurred during the carrying out of measures taken to suppress it.

IV.—ADDITIONAL FACTS SUPPORTING THE VIEW THAT INSANITARY CONDITIONS INSIDE DWELLINGS ARE THE CHIEF CAUSES OF THE SPREAD AND VIRULENCE OF PLAGUE.

Incidence greater in lower than in higher flats of many-storeyed houses.

9. Several witnesses have stated that in chawls and in the larger houses occupied by the poorer classes a greater number of cases were found in the lower than the upper storeys.

Mr. Gokhale, Professor of History and Political Economy in the Fergusson College, Poona, and a plague volunteer worker, stated: "For four or five months I was going
about with the search parties. We found that most of the cases which occurred 21,519.
were on the ground floor;" and he added that they were more crowded and worse 21,521-2.
ventilated than the upper floors. Major Deane, I.M.S., gave evidence to the same effect regarding Bombay. "There was not the same number of cases occurring in the
upper storeys of the large chawls there." This statement was repeated by Major 2784.
Dimmock, I.M.S.; and Mr. Nield Cook has recorded that in the Calcutta outbreak of 20,422.
1898, the cases were more than three times as numerous in the lower than in the Vol. I., Appendix
upper storeys of the relatively very few large and well built houses of that city in XX., p. 474.
which plague had occurred.

For the purpose of illustrating the influence of ventilation on the mortality from plague, Lieut.-Col. Weir, I.M.S., placed before the Commission a carefully prepared table dealing with the proportion of deaths to attacks in many-storeyed houses in the wards of Bombay, and in which the percentage of deaths to attacks on each floor was separately stated. It appears from this table that the mortality steadily diminishes
from the ground floor upwards to the highest floor; the average percentage of 916.
mortality in the houses in seven wards being 84·7 in the ground floors, 75·5 in the first floor, 67·3 in the second floor, 59·7 in the third floor, 48·1 in the fourth floor, and 45·4 in the fifth floor.

The significance of these figures vie on to the

Freedom from plague of inmates of well-ventilated and lighted houses.

10. There is also evidence which shows that the disease does not usually affect or spread
among the inmates of the better-class houses, if they be well ventilated and lighted
and not overcrowded, even when they are situated in the midst of plague-affected
districts. Thus, according to Mr. Patwardhan, Municipal Commissioner of Poona,
21,547. "well-ventilated spacious houses, exposed to heat and sun, which were surrounded
by affected houses, could not have escaped the contagion. They were in several
cases vacated and locked, or in many cases occupied by a few servants and others.
They were not disinfected, and yet no cases occurred in them, and they were re-
22,649. occupied with safety." According to Lieutenant Anderson, I.S.C., "It is a notable
fact that in the really good houses, some of which were situated in the very heart
of the most highly infected quarter, practically no cases occurred"; while his
Snow's Report, large experience at Bombay has led Lieut.-Colonel Weir to conclude that the plague
p. 174. "organism does not seem to be able to develop virulently or survive where
there are free currents of air, and hence it passes by or little affects well-ventilated
buildings." To the same effect was the evidence of Major Hardy, that in Dharwar
2307–9. plague did not much occur in the large double-storeyed and well-ventilated houses,
but chiefly affected the inmates of the small, low houses, either without windows, or
with windows which were generally shut up; of Colonel McConaghy, I.M.S., that in
houses in which plague cases had occurred it was not uncommon for several of the
12,880. inmates to be infected if the houses were "small, unhealthy, and badly ventilated,
especially if the floors were of earth," whereas "in the better class of houses, which
were well ventilated, and with upper storeys, very few of the friends who came in
contact with the patient suffered"; and of Captain Childe, I.M.S., Mr. Giles, and
1447, 11,345–7, Mr. Patwardhan, that no cases of plague occurred in well-built and well-ventilated
21,538. houses, even although dead rats had been found in them, during outbreaks of plague in
Bombay, Karachi and Poona.

Inmates of the better-class houses attacked if ventilation inadequate.

11. On the other hand, plague has undoubtedly occurred and extended to the better-
class houses of the richer Natives. Mr. Stewart, I.C.S., Acting Secretary to the
Government of Bombay, stated that the houses in Nasik are of all kinds, and that
16,977–8. he could not say that plague chiefly occurred in the bad houses, obviously meaning
badly built. "Some were exceedingly well built—the big houses—but they were
dark, badly lighted, and badly ventilated"; and it was in the well built houses
having these serious defects that plague chiefly occurred. The one-roomed houses, in
16,982. which plague cases were also abundant, were overcrowded, and had practically no
16,983. means of ventilation but the doorway; "there is a window, but it is generally blocked up."
Referring to the Kaira District, Mr. Kabraji, I.C.S., stated: "It has been observed that
by far the largest majority of plague cases, if not all, occur when the sleeping rooms
19,515. are badly or insufficiently ventilated or lighted. Even if there are windows or venti-
lators, the people are in the habit of closing them at night. This may sufficiently account
for the occurrence of plague among the well-to-do classes." A specific illustration
of this was given by Captain Thomson, I.M.S. The jailer's house at Satara "is a
well-ventilated house. The jailer's is an ideally perfect house, even for Europeans
to live in, but as he only used the centre room, which may be 14 feet × 12 feet, for
himself, his wife, his brother in-law, and six children, who all sleep on the floor,
22,384. and in the cold weather they have a charcoal brazier in the centre of the floor, and
cover their heads with razáis, blankets, and so on, and all the doors and windows are
shut, they have made this naturally well-ventilated house perfectly insanitary, and
consequently there was plague last year, and there was also plague this year."
22,385. When his dau [illegible] attacked, in January 1898, Captain Thomson said: "Now,
surely, yo [illegible] r b [illegible] preserve your health," and he replied,

12. An endeavour has been made to show that the influence of overcrowding upon the Incidence of
extension and virulence of plague is relatively unimportant, because, in several places, plague not neces-
the disease has attacked sparsely inhabited districts with as great severity as those sarily co-relative
which were densely populated. The prejudicial effects of concentration or density of with density of population.
population in inhabited areas are probably much less operative in India than in this 8707.
country; for in this country nearly all the houses, however unsatisfactory their sanitary conditions may sometimes be, are provided with windows opening from each living room directly to the outside air, whereas in India this is far from being the case. Concentration of population has, therefore, a more definite and readily appreciable effect in inducing disease in this country than it has in India. It may not be superfluous to add that density of population is not synonymous with overcrowding of the interior of houses, a subject which is discussed in paragraphs 58 to 64 of this Memorandum, and that the failure of Mr. Hankin's and Lieut.-Colonel Weir's statistics to prove that density of population is causally related to high plague-incidence, has no direct or necessary bearing upon the question of plague being fostered by insanitary conditions in the interior of occupied houses.

13. At the same time, density of population, although by no means co-relative with overcrowding of the interior of dwellings, is no doubt in many cases accompanied with this overcrowding, and is in itself a frequent cause of defective ventilation and light, with consequent vitiation of the atmosphere. It is therefore of importance to examine further into the conditions prevailing in the cities and towns in which plague cases have been numerous in sparsely populated areas.

In Ahmedabad, plague is stated to have occurred more in the suburbs than in the
city itself. The congestion in the city proper amounted to 100 persons to the acre—
the average in the nine largest towns in Scotland being 38·5 with a maximum of 58·6 13,938.
in Glasgow—the houses, however, were several-storeyed, with an uncovered courtyard
in the middle of each, into which most of the rooms opened by windows, and they had
doors at the side opposite to the courtyard. In the suburban plague-affected area, on
the other hand, the houses were single-storeyed and were built on three sides of a
square, into which the door of each house opened; but they had no openings into the 13,976-85.
outer air except the doorway, and "perhaps two loopholes, one on each side of the door,
and the ventilation was chiefly through the tiled roof." Lieut.-Colonel Weir also told 25,675.
us that, notwithstanding the ravages made by plague in the highly congested districts
of Bombay, its virulence was actually greater in some of the relatively sparsely 25,690-2.
populated suburbs. The houses of the suburbs, however, were "the old-fashioned 25,691.
houses which have a number of inner rooms, not communicating directly with
the external air, and very ill-ventilated," dark, and damp; and in these rooms the 25,698.
people generally slept. Further, when plague was most prevalent in the suburbs, the
houses there were exceptionally overcrowded, because of an exodus from the previously
affected city. When asked if the attacks and mortality from plague in Morland Road, 25,715.
a new street with new houses, were as bad as or worse than in the worst portions of
Bombay, he replied, "I can only answer in a very general way. . . . I think
they were just as bad, although Morland Road has hundreds of yards of open
ground on one side." On the further inquiry, whether there were any special
conditions and circumstances in the houses in Morland Road favourable to the 25,784-5.
prevalence of plague, he, however, said, "Yes; there are a very large number of
poor people and outcasts living in very crowded rooms, and rooms which they crowd
with screens and purdas"; and he also said that the conditions "are exactly the
same inside the rooms only, but not outside," as in the most crowded buildings
of the town. Sewree and Mahim are stated to be two of the most sparsely populated
districts of Bombay, and yet plague severely attacked them. Apparently, however, the
outbreaks occurred in the fishing villages of each district, and the houses in these Gatacre's Report,
villages are described as being so constructed as to be effectually deprived of ventilation p. 190-1.
and light, while drainage is totally absent. Other instances that have been cited, such
as Parel and Worli, have elsewhere been dealt with (paragraphs 7 and 85).*

So far, therefore, as the means for admitting air and light into the interior of houses are concerned, a highly congested area may actually be more favoured than one only sparsely populated, and when this occurs plague becomes more virulent in the houses of the less densely populated district.

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* The manner in which originally good houses with surrounding open spaces and sufficiently ventilated and lighted rooms are converted into insanitary houses with unventilated and dark rooms has been described by Lieut.-Colonel Weir in Snow's Report, p. 101, paragraph 322, and by Colonel Fawcett in reply to Question 21,292.

Certain classes of people who live in well-ventilated houses or in the open air have been little affected.
Snow's Report, p. 147, para. 566.
Snow's Report, p. 174, paras. 621, 622.
917.
Confirmed also by Drs. Dyson and Calvert at p. 1 of their Report on Plague in Bombay, 1897.
Snow's Report, p. 147, para. 565.

14. Leading to the same general conclusion is the evidence which indicates that certain classes of the community living in well-ventilated houses have been but little affected by plague. In Bombay, where a part of the police force lived in properly constructed quarters and the remainder lived in native houses, it was found that only four cases of plague occurred among the former, while 151 occurred among the latter, showing, according to Lieut.-Colonel Weir, "that in well-ventilated buildings the disease does not readily develop." In the municipal chawls, occupied by scavengers or sweepers, who clean the streets and galis, and by halalkhores, who clean the privies, "very few cases occur, . . . while the people living in municipal chawls suffer little, the same class living in the ordinary buildings of the city, close to the municipal chawls, suffer as the rest of the population. . . . I have referred to the extraordinary freedom of the halalkhores and scavengers living in municipal chawls, but a similar immunity has been observed in the case of disreputable women living in many portions of the city. Dr. Rogers Pasha and Professor Bitter, who examined with me the municipal chawls or barracks in Kamathipura and the houses of the disreputable classes in the same localities, agreed that the conditions of better ventilation and less overcrowding were the conditions in which these buildings differed from the houses around them. The servants of the tramway company, when placed in huts, suffered as little as the most favoured classes. . . . At Falkland Road, where the company had erected, for the segregation of the establishment, huts on open ground, and segregated 150 men in the camp, not one case occurred, and yet the huts were in the centre of a district greatly affected—the district of Kamathipura."

22,128.
13,480.
22,267.

Lieut.-Colonel Hay, I.S.C., had noticed that "the fakirs were immune. A very large number of fakirs came to Bhiwandi. They pass through it on their way to somewhere. I never heard of a single case among them. . . . They live an outdoor life; and I think that is the reason why they do not get attacked." It has been observed by Mr. Hyde-Cates that there were no cases among the Waghris, who are employed as shikaris and also as coolies in Mandvi, but live in grass huts outside the town, nor among the Natras, or gipsies, who also live in "the open," but "were to be met every day in the town, following their occupations of begging and of selling small iron things for household use." For this reason, also, it was believed that no case occurred among the 186 wandering beggars of Satara, although they visited that town every day, and specially collected together there for alms, twice weekly.

Immunity of Europeans.
22,263, 22,426.
Snow's Report, p. 152, paras. 577, 580.
917.
7168.

15. The remarkable immunity of Europeans has nearly always been explained on the same grounds. Lieut.-Colonel Weir stated: "The small proportion of attacks amongst Europeans . . . is, I think, entirely due to the ventilation of the buildings, the open condition of the buildings they occupy. There does not seem to me to be any other explanation." Major Charles, I.M.S., has endorsed this view. "For a European in a properly constructed house I think there is not very much danger."

Large incidence among domestic servants.
Vol. I., Appendix XIV., p. 378;
Snow's Report, p. 190, para. 708.
Campbell's Report, p. 185;
23,965; 24,137-9.
Campbell's Report, p. 185;
20,539-47.
18,189-18,199.
Snow's Report, p. 102, para. 328; p. 151, para. 576.
20,474.
1447.
Snow's Report, p. 106, paras. 349, 350.

16. While, however, Europeans as a class enjoyed a conspicuous freedom from infection, domestic servants, largely employed by Europeans, were numerously affected, with disastrous results. These servants live generally in small shed-like houses or huts, entirely separate from the bungalows, or residences, of their masters, but situated in the same open compound. In accordance with a prevailing native custom, the huts often contain not only the servants and their wives and families, but also, in many cases, numerous other relatives. They are, accordingly, frequently overcrowded, and the generally scanty means provided for admitting air and light into the huts are rendered inoperative, as they are carefully blocked up at night, and especially during cold weather. This was conspicuously illustrated at Malabar Hill, Bombay, where the servants were attacked, even after their quarters had been disinfected, "and the epidemic spread all through the servants' houses, although very few Europeans were attacked"; and it was observed that even in a bungalow in which rats had died of plague, none of the inmates acquired the disease. In the Marine Lines at Bombay the plague incidence in the servants' quarters was also very high, while in the adjoining bungalows, in many instances connected with the servants' quarters by matting sheds and covered ways, the incidence was insignificant. There were, however, "very few houses occupied by servants in the Marine Lines that had a window."

Immunity and prevalence among different castes.

17. Relative immunity was also observed to occur in other classes of the community. In the Brahmapuri Hindu Hospital at Bombay, the mortality from plague was, in two periods, 90 and 83 per cent., while the average in other four hospitals in which

other castes were treated was 38·8 per cent. Commenting on this, Captain Childe, I.M.S., writes: “From the above statistics it will be seen that the Hindus suffer by far the worse; but, considering the ghastly conditions of their existence, the terrible overcrowding in low, badly built, badly ventilated, and worse lighted houses, the total absence of drainage, and the most degrading personal filth, the only marvel is that the whole population has not been annihilated.”

Gatacre's Report, p. 225.

Lieut.-Colonel Nariman, I.M.S., stated that out of 85 indigenous cases of plague in Surat during 1896–97, 61 occurred among the 72,568 Hindus living in the city, and only four among the 20,377 Muhammadans; while no indigenous cases occurred among the 5,893 Parsees, and no cases, imported or indigenous, among the Europeans and Eurasians. When asked if there was any difference in the habitations of these different sections of the citizens, he replied, “As far as the habitations are concerned, Europeans and Parsees generally live in more healthy localities. There is no overcrowding in their houses, but amongst the Hindus, of course, there is always overcrowding.” As to the Muhammadans, he stated, “I do not believe that there is so much overcrowding amongst them as among the Hindus.” He added that the habitations of the Eurasians are “like those of the Parsees and Europeans.”

15,632-3.
15,637.
15,638
15,641.

Dr. Blaney, of Bombay, who when examined at first showed an inclination to explain the varying mortality of different castes by susceptibilities due to race, diet and habits, when afterwards asked to what extent the houses of the people affected the immunity, replied, “There the Commission has hit the great point. . . . Overcrowding is *the* great question in Bombay with regard to plague, with reference to the extent, the severity, and preservation of infection in houses. . . . I only wish to emphasize, as much as I possibly can, that the overcrowding has had a great deal to do with the intensity of the epidemic and the greatness of it.”

17,681.
17,688.

A similar opinion was expressed by Captain Thomson, I.M.S. Referring to the immunity and to the difference of incidence among races and castes at Surat, he stated: “In the last epidemic, although we had 45 adult Europeans, 20 European children, and 125 European soldiers, not one was attacked, although 20 Europeans and one lady nurse were daily engaged in plague operations. They remained completely immune.” “Then we had no Eurasians, native Christians, missionaries, or their families attacked, and there were 527 such in Satara City and cantonment. Thirdly, no Parsees were attacked. They comprised 50 souls. Of the hospital servants, ward boys, sweepers, corpse-bearers, ayahs, of whom there were from 60 to 65 in the first epidemic, only one was attacked, and that is mentioned because it can be clearly showed how he became attacked. . . . The depôt Sepoys, the 3rd Bombay Light Infantry, with their wives and families, remained immune.” When asked for an explanation which would cover all these cases of immunity, he replied, “It depends on the habits of the people. Referring to the castes, it depends on the conditions of ventilation of the houses and the habits of the people as regards their knowledge of the necessity for fresh air and cleanliness in and about their houses.”

22,263.
22,264.
22,265.
22,274.

This statement has been emphasized and corroborated by the circumstance that, when the conditions of ventilation differ in the houses of members of the same caste or section of the inhabitants, the plague incidence and mortality also differ. Thus, Mr. Madhava Rao has reported, “that the members of the Muhammadan community living in No. 2 Ward, whose number approximates to 3,686, had only 73 plague deaths among them, or something less than 2 per cent., while the Muhammadan population of the rest of the city, numbering about 9,942, had a mortality of 460, or 4·6 per cent.” The reason assigned for the comparatively greater immunity enjoyed by the former is “that their houses are better ventilated, and the custom of gosha does not prevail among them.”

Report on Plague in the Mysore State, p. 35, para. 118.

Immunity in evacuation camps due to good ventilation.

18. We have elsewhere discussed the evidence regarding the effect on the progress of plague which has followed the removal of a part or the whole of the inhabitants of a plague-affected place to temporary habitations in the open country, and we have stated that in our opinion, “considered generally, it is probably a beneficial measure.” In the estimation of many of those who have been actively employed in carrying out measures for the suppression of plague, complete as distinguished from partial evacuation of an infected place is the most successful of all measures, provided that certain obvious auxiliary requirements are ensured, such as the provision of proper sites and temporary buildings, the immediate isolation of any cases that may occur, and the prevention of conveyance of infection by persons or things either into or out of the confines of the camp. As was comprehensively expressed by one witness, it “is the one thing, every officer recognises that evacuation is successful.”

Our Report, para. 634.
10,364; 10,374–77; 10,464–9; 10,634; 11,849; 13,452; 14,452; 15,220; 16,987–89; 18,406–22; 20,238; 20,441–2; 22,288; 22,737; 23,169-98; 24,312-4; 24,363; 26,543-8; 26,672.

Inglis' Report, pp. 10, 107. James' Report, p. 105. 11,248–251. Inglis' Report, pp. 7, 107, 122, 157. James' Report, p. 79. 2169–91. Evidence, Vol. I., p. 92, Statement A; 2192. 16,884–95; 19,484.

19. On the other hand, in several places complete evacuation was not adopted as a plague measure, or was postponed until the outbreak had already existed for several weeks, and the course of the outbreak in them serves to illustrate the value of this plague measure. The three villages in the Jullunder and Hoshiarpur Districts of the Punjab which suffered most severely from plague were those in which early evacuation was not enforced. Of these, the disease was most virulent in Kariha, a village with a population of 1,846, which was first affected on the 5th of April 1898, but, because of the determined opposition of the inhabitants, was not evacuated until the end of that month. During this period of about three weeks, there were at least 130 deaths from plague, while only 13 deaths occurred after evacuation had been completely accomplished. In four villages in the Dharwar District, in which evacuation was not carried out because of the rains and the want of suitable hutting materials, the percentage of attacks to population ranged between 30 and 47, and in one of them the plague death-rate was 35 per cent. of the total inhabitants. In Byahatti, one of these villages, with a population of 3,589, plague "spread with intense rapidity," and Mr. Westrop, the Assistant Collector, thought that although this might be due to climatic conditions, he would "be inclined to attribute it to the stay-at-home habits of the people in the rains, and the absence of ventilation in the overcrowded houses." For similar reasons, evacuation was postponed at Igatpuri, a town of 6,000 inhabitants in the Nasik District, but all the houses were disinfected with perchloride of mercury, and then thoroughly cleansed; and 518 cases and 421 deaths occurred during the thirteen weeks that elapsed before evacuation was resorted to.

23,041. Evidence, Vol. I., Appendix, XX, pp. 477–8.

20. The value of this plague measure has also been illustrated in the case of single families, and of several families collected together in one building. One of the most striking examples of the former was mentioned by Lieut.-Colonel Peters, I.M.S. Two of a large family of patawallas, in Belgaum, "came to the camp, and four others perished in the house." Subsequently, the remaining survivors, 13 in all, were removed to the health camp, and "there was not a single case among them." An example of the latter has been reported in Calcutta, where, after it had been discovered that there had probably been 12 deaths from plague in a most insanitary bustee in Roop Chand Roy's Street, an opportunity was given, in accordance with the policy then followed, to the 200 inhabitants of the bustee to remove to a building provided for them by the Municipality. None of them, however, availed themselves of the opportunity, but preferred to adopt the option of finding lodgings for themselves, with the result that at least 12 cases of plague occurred which could be traced to Roop Chand Roy's Street, besides other cases which were not certainly diagnosed, as they had not been seen during life by a qualified medical man, and that seven widely scattered foci of infection were originated.

8; 9; 1355; 2168–2200; 5926; 6036; 9054; 9225; 10,464–5; 14,671–5; 15,775–7; 17,295–6; 18,075; 20,234; 21,320–2; 21,538–9; 21,832; 23,938–42; 24,058–63; Inglis' Report, p. 4.

21. The largest amount of evidence in favour of the success of evacuation has, however, been obtained from the numerous instances in which the removal to an evacuation camp of the inhabitants of a town or village in which plague had been extending, often with great rapidity and virulence, was almost immediately followed by a decided diminution or even by an entire cessation of further cases.

It is important to consider what explanation can be found for these valuable results, as thereby a cause of the propagation and virulence of plague may be rendered manifest.

Immunity in camps not due merely to removal from the infected place or site.

12,081–2; 13,808–12; 22,041. 14,623–4; 14675; 17,295; 18,074. 22,737–43; 22,775; 22,786.

22. Several explanations suggest themselves. These results, it might be supposed, are due to removal from the place where the cases of plague have been occurring, on the supposition that that place contains the cause of the infection in the floor or walls of the affected houses, or elsewhere than in the patients or the movable contents of the houses. Admitting that a place or site may become infected, the fact remains that the introduction of persons suffering from plague into dwellings where previously no case had occurred has often been known quickly to infect the healthy inmates. Further, the history of nearly all evacuation camps shows that infection has been introduced into them by the unavoidable admission of persons who were in the incubation stage and afterwards developed the disease, and also by failure in the early isolation of plague cases otherwise introduced into the camps; and yet, although opportunities have thus been given for the infection of the site, it is conspicuously manifest that plague rarely extends in these camps, if the huts be so arranged and constructed as to secure adequate ventilation. On the other hand, there are several instances, as that of Uran, and of other places cited below, in which the removal to an evacuation camp from a place in which plague was actively spreading entirely failed to suppress the disease among the persons who had been removed; the failure being associated with inadequacy in the

ventilation of the huts, although, it may fully be conceded, in some instances, also, with omission of the precautions, required in all infectious diseases, to prevent extension from infected persons and things.

Immunity in camps cannot be explained by disinfection with chemical substances.

23. Again, it might be supposed that the cessation of further cases was due to the disinfection with chemical substances, frequently practised of the effects and, less frequently, even of the persons of the inhabitants of the infected place, previously to their admission into the camp. Against this supposition it has to be observed that the disinfection alluded to was not always carried out, as in the successful evacuations in Poona Cantonment described by Lieut.-Colonel Fawcett, and in others referred to in the margin. It was only rarely carried out in villages, and in many of the places where it was included among the precautionary measures preceding evacuation, it was performed in only an imperfect manner, and did not overtake all the probably infected articles taken into the camps; while, notwithstanding, plague did not materially extend in the camps. In so far as the site is concerned, it was not customary to apply disinfectants to the floors of huts, except in a few camps where the operation, however, was restricted to the huts in which there had actually been cases of plague; and it may here be remarked that in many camps where evacuation was successful the floors of the huts resembled those of the houses from which the camp inmates had been removed, in so far that they consisted of mud and cowdung, and also that the presence of rats in these evacuation camps has several times been noted. It is, however, undoubted that in Kumaun and Garhwal, the inhabitants of plague-infected houses and villages did not practise disinfection by chemical substances of persons or clothes, or of the temporary huts into which they removed, and yet almost no case of plague occurred in these huts.

James, Jullundur, &c., Report, 161. 9294–5; 10,471; 11,144–48; 18,582; 18,600–1; 21,251–3.

James's Report, p. 160; 23,071–2.

Failures of evacuation camps due to overcrowding and insufficient ventilation.

24. Assistance in finding an explanation of the beneficial results of the complete evacuation of an infected place may likewise be obtained from a consideration of some of the few instances in which these results were not entirely secured. No doubt, failure was occasionally produced by the isolation of cases occurring in camp not having been immediately affected or by the introduction into the camp of infected articles. Another cause has, however, been made apparent by the evidence placed before us. 10,603.

In Captain James' Report on the outbreak of plague in the Punjab, it is stated, "The huts made by the villagers may be, and usually are, more comfortable than Government ones, but they certainly do not let in the same amount of light and air, and are therefore not so serviceable for the present purpose." James's Report, p. 103.

Having described the results of evacuation in Jawalapur, Mr. Winter, I.C.S., adds, "If the people had all been put into Government camps, I think it is possible that there would have been fewer cases in camp. Of course, as they built their own camps, they did it as cheaply as they could. They built the huts adjoining one another or very close together. The huts were thickly populated, and there was not much circulation of air." 9178 (last para.).

When asked, "Is there any exceptional condition with regard to the huts in those camps where you had no success?", Mr. Dodgson, I.C.S., replied, "The absence of success is chiefly due to the rain, not to the nature of the huts. The people build their huts much more solidly during the rains than they do at this time of the year. During the rains they are tighter and closer, and are like little beehives, with a little door which you can just walk in at, and there is, practically, no ventilation whatever." 22,048.

One of the chief causes of incomplete success during the rains is attributed, by Lieutenant Anderson, I.S.C., to the fact that the huts constructed by the villagers are frequently worse ventilated than the houses in the villages, with the result "that a large number in one hut will frequently get plague." 22,607–9.

To the same effect is the observation of Captain C. H. James, I.M.S., that if any further proof of the value of evacuation were required it would be found, even in the voluntary camps of villagers, "in the fact that as the weather became warmer, and the people huddled less together in the camps, the effects of evacuation became more and more marked." James's Report, p. 122 (for an example, *see* pp. 20–21 and Evidence 10,384, relating to Sirhal Kazian).

Referring to the unauthorised camps at Surat, Mr. Judge found that, where no proper supervision was exercised and the people were allowed to crowd together in the huts and shut out ventilation, "the disease raged quite as freely . . . as it did in a town." 16,016.

Mr. Kabraji, I.C.S., informed the Commission that, with the view of securing "the free admission of daylight and fresh air . . . we insist that when people 19,515.

evacuate a village and go into the fields they shall not create the same unhealthy conditions again by making air-tight and badly lighted huts as they are prone to do."

Mr. Giles, Acting Commissioner in Sind, stated that there were no cases in well- 11,263. constructed camps, but "where they were huddled together, as a few of Dr. Seymour's camps were, there were a few cases of plague." He also ascribed the failure of voluntary evacuation in the huts erected in date groves at Rohri principally to the 12,120-1. insanitary condition of the ground and to the very defective ventilation and light, the date trees being "very thick . . . so that you could hardly see the sun at all."*

The following evidence bearing on this point, given by Captain Thomson, I.M.S., is particularly instructive: "You wish to point out that the mere fact of evacuation is not sufficient, but that there must be certain things attended to in that evacuation: what do you think is the most important?—That the Government huts should be 22,289. ready for the whole population of the area to be affected. It is useless removing them from structurally insanitary houses to huts equally air-tight, because that 22,290. would defeat the effect of the evacuation almost entirely." "Is that the result of your experience?—It is from my experience of Satara, and some villages which I know continued to have plague after evacuation." "Can you narrate your experience?—The town of Limb was completely evacuated, and yet plague continued for months afterwards, because the people were allowed to hut themselves in an area of five miles round the village, and they did not go into Government-constructed huts. They continued to have plague for months after evacuation. Plague lasted eight weeks before evacuation, with 45 deaths, and 22 weeks after 22,291-6. with 521 deaths." "How do you account for that?—Because they went into badly ventilated huts." "What were the characteristics of these huts which produced the bad ventilation?—First of all, their structure. They were made of bamboo poles, and they used matting for the walls, while the roof was constructed of grass. We leave air-spaces on the top, but if the people are allowed they build their own huts with karbi, and daub them inside and outside and make them as air-tight as possible, with very small openings, and they will also overcrowd them." "That was the condition of the huts in the instance which you have given?—Yes, of those huts in which plague continued to occur." . . . "Have you any other definite instance in which the evacuated people continued to have plague among them when that continuation was in your opinion due to want of ventilation in the huts they occupied?—The town of Rahmatpur, of 6,670 inhabitants, had plague for 15 weeks after complete evacuation, owing to the insanitary huts to which they went. Before evacuation, plague had lasted seven weeks, and there were 106 deaths before and 162 deaths after evacuation." "Will you describe those huts?—They have the same characteristics as those of Limb which I have described. I have seen them."

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25. It would thus appear that the remarkable success of complete evacuation and the equally remarkable immunity from plague in evacuation camps are mainly to be attributed to the adequate provision of unpolluted air and of sunlight in these camps.

Plague does not extend in hospitals.
12,942.
Excluding moribund cases, hospital mortality relatively low.
Gatacre's Report, pp. 54, 69; 10,401-3; 15,267-8; 21,540; 25,026. Hutcheson's Report, pp. 20, 21.

26. Equally striking in its indications is the evidence derived from hospital experience. Relatively to the conditions which exist in native houses, the hospitals are freely supplied with air and light, and the space appropriated to each patient is ample. For example, in the Parel Hospital, Bombay, "each patient had nearly 2,000 cubic feet of air space and free perflation of air." The experience of Bombay and of other places shows that, if patients who died within the first 24 hours are excluded, the general mortality in hospitals was decidedly under that in private houses. Even in the very few instances in which the surroundings of the hospitals have not been satisfactory, where, for instance, they have been "completely shut in and surrounded by other larger houses," or built on a site with "many sanitary drawbacks," or placed in a crowded locality, the mortality, relatively to that in Native houses, was still favourable, and, above all, plague did not extend among the inmates of the hospital.

27. The latter is a prominent circumstance in the experience of all plague hospitals; and it was displayed in some of them, although the ward servants went about bare-footed, and in nearly all, if not all plague hospitals, even although ward servants and

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* It is of interest to find that Professor Koch has observed that in an endemic centre at Uganda and in the Victoria Nyanza Country, in Equatorial Africa, the plague incidence is especially high in banana palm groves. The affected villages lie in dense banana groves, which are almost impenetrable by light and air, and swarm with rats. According to Professor Koch, they are thus typical (förmliche) breeding places of infectious diseases, and there is no cause for wonder if the plague takes root in such a district. (Deutsche Medicinische Wochenschrift, 14. Juli, 1898, 439.)

numerous friends of patients were brought daily and nightly into the closest personal contact with pneumonic as well as with bubonic cases of plague. The following are illustrative examples:—

In the Parel Hospital, Bombay, "in upwards of 240 instances the friends of patients attended their sick, and in 20 instances scarcely even left the bedside, and in no single instance did the disease spread to the friends. Out of more than 140 attendants on the sick belonging to the hospital staff from time to time, only one sweeper was attacked, and he had been constantly helping in the *post-mortem* room, and had a very mild attack with small axillary bubo . . . . In three cases amongst hospital orderlies, there were special circumstances of contagion existing very likely to lead to direct inoculation, and are, therefore, not considered instances of spread of the disease from mere attendance on the sick." In the Arthur Road Hospital, while 4,000 cases of plague were under treatment, only six attendants and one medical man contracted the disease; but the former did not live in the hospital but "outside in infected houses," and the latter occupied a dwelling in an insanitary locality.* In the Grant Road Hospital, "of about 400 people—men, women, and children—who either visited their sick friends or remained constantly by their bedsides, together with the cases under observation, in not a single instance did any of these persons contract the plague. But one of the ward orderlies doing duty in the hospital became affected by direct contagion in consequence of drinking the remnants of stimulants left in feeding cups by patients who did not consume the whole contents, and, most probably, after some cup had been in contact with the mouth of a plague-pneumonic case." Referring to the same hospital, but at a different period of the epidemic, Dr. Hutchinson states: "Relatives of patients were admitted at any time during the day, only two being allowed to visit each patient at a time. At night only relatives of the patients who were dangerously ill were admitted. It was found impossible to prevent them from handling the patients, yet, notwithstanding their constant and close contact, the occurrence of only two cases of plague amongst the relations was brought to notice."

Snow's Report, pp. 165-8, 216-7; Nathan's "History of the Plague in India," Vol. I., p. 289.
Campbell's Report, pp. 150, 160.
Snow's Report, pp. 209, 212, 269.
Gatacre's Report, p. 51.
20,551; 20,973–4.
Gatacre's Report, p. 94.
Campbell's Report, pp. 134–5.

In the Medical College Hospital at Calcutta, the friends of the patients were encouraged to go into the hospital and stay with the sick, and none of them were known to have become infected, although they remained beside and attended upon pneumonic as well as bubonic cases of plague. There were no cases of plague among the 18 attendants in the Chaudni Hospital, nor among the 56 in the Mayo Hospital.

6963–5.
7020–1.

In the General Plague Hospital at Surat, "out of about 900 attendants who lived in the hospital to look after their relatives, only 12 were attacked with plague. Of these, eight were attacked within 24 hours of admission, two within 48 hours, and one each on the 10th day and 20th day, respectively." In the Hindu Hospital of this town, between October 1897 and the end of January 1898, there were only 19 cases of plague among 1,200 relatives and friends who lived in the hospital with the patients, and several of these cases occurred within the incubation period of 10 days after these attendants had entered the hospital.

15,796.
16,149–52; 21,593.

In the General Plague Hospital at Poona, where, from June 1897 to March 1898, 4,179 patients were treated, no case occurred among the friends who attended the patients and were at least equal in number to them; while of the hospital establishment, consisting at one time of 320 persons, only 26 contracted plague, but it is difficult to know how many even in this relatively small number contracted the disease in the hospital, as all the members of the establishment were frequently given leave to visit their homes in the city. In the Hindu Hospital, Poona, 637 friends of the patients acted as personal attendants, between March 1897 and March 1898, and only four of them became infected with plague.

Lloyd Jones' Report on Poona Hospital, p. 10.
21,539.

In the Plague Hospital of Hubli, Mr. Cappel stated that there had been only two cases of infection among the attendants "who were with the patients day and night," and that there had been only five cases in the Dharwar Hospital "among the people who stayed and slept all night long by the bedside of the patients."

1704.

In the eleven Plague Hospitals at Porbandar, none of the members of the hospital staffs were attacked and only two of the numerous relatives and friends who attended the patients, but they are stated to have been attacked within the period of incubation after the date of entrance into hospital.

13.702, 13,7[illegible]–6.

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* The absence of extension in this hospital is noteworthy, as rats are stated to have been numerous in the hospital compound. 21,008–10.

R. N. Jadhav's Report on the Working of the Daliawadi Plague Hospital, 1897–8, pp. 14, 15, 31.

In the Daliawadi Plague Hospital of Baroda City, where it is estimated that about 700 friends and relatives attended on the patients and often slept in the same ward with them, only 10 became infected; and the members of the hospital establishment altogether escaped, although most of the servants "were in the habit of going all over the hospital barefooted, with numberless cracks and fissures on the soles of their feet."

22,489. In four hospitals at Satara, employing 106 servants, only two were affected with plague, and neither derived the infection from the hospital.

In the Plague Hospital at Ankleshwar, Mr. Candy, I.C.S., Collector of Broach, arranged that the immediate relatives should be admitted with the patients, "that the husbands, wives, and family should be together." Sometimes there were "four or five children all round a sick bed," and there was scarcely "one instance of anybody being any worse for that." Mr. Candy attributed this immunity "to the excellent atmosphere which is maintained in a hospital," and he added, "If these people had remained with their sick in their own houses, where they shut up the doors and windows, so that the place became a hothouse, a forcing house for the plague bacilli, they would suffer." 15,500.

Further, even when plague cases were admitted amongst the ordinary patients in a general ward, the experience was the same. 1439. "In the Jamsetjee Hospital at the beginning of the epidemic a large number of cases of plague were let in by mistake at first, not being properly diagnosed; but no cases of plague spread from them at all, neither among the patients nor the attendants."

So encouraging has been the experience that plague does not spread in a hospital, that it has been asserted that the ward of a plague hospital is "one of the safest places during an epidemic." Gatacre's Report, p. 51; 2923.

Immunity in hospitals contrasts remarkably with great and rapid extension in native houses.

Gatacre's Report, pp. 50, 222; 21,540; 25,828–9; 1725; 3448–73; 6193; 12,333; 12,482; 14,448; 17,589; 17,984; 19,597–617; 25,831.

28. It is notorious that this statement cannot be made in regard to the great majority of the houses of Natives. Plague is well known to spread in them with appalling rapidity, although the inhabitants of the houses are actually the persons who, when transferred to hospitals, remain unaffected even when surrounded by more numerous sources of human infection than are present in their houses. The introduction of an infected person into one of these houses has been known frequently to cause four or five cases of plague among the limited number of the inmates, and, less frequently, seven, eight, nine, ten, and twenty inmates, and even the whole of the inmates of the house have become infected, although some of the houses had been disinfected on the death of the first patient, and although in many of these instances the infection was communicated by patients suffering from the more common bubonic, and not from the less common and more infectious pneumonic type of plague.

Snow's Report, pp. 54–70. 22,114–8; 23,359. 12,332–4; 12,479.

29. In some towns, also, most of the plague patients were treated in their own dwellings. In Bhiwandi, in the Thana District, this system proved a failure, as a very severe outbreak resulted, with a case incidence of 2,000 in an estimated population of considerably under 10,000; and Lieut.-Colonel Hay, I.S.C., calculated that, "supposing one case occurred in a house, it was 100 to 3 against an inmate getting plague if he went at once into segregation, or if he attended his friends in hospital outside, but if he remained there" (in the house) "out of every 100 at least 16 were taken." In Karachi, the result, according to Dr. Niblock, was that, "from the point of view of preventing the spread of the disease, it was very bad indeed;" and he instanced a house containing from 35 to 40 inhabitants in which no less than 21 people "caught the disease from one another." 22,803–25. In Belgaum, where during 1898–99 the patients were left in their houses along with the other inmates, the outbreak continued, with a high mortality, for at least seven months, and cases kept occurring one after the other in disinfected houses. 2192. In Byahatti, in the Dharwar District, after all the non-affected had been removed to evacuation camps, the sick, numbering about 150, were left in the village and treated in their houses, each with one attendant, and many cases occurred among the attendants, although all the infected houses had been disinfected.

Causes of immunity in hospitals.

1440–3; 10,374–7; Gatacre's Report, p. 69.

30. Among the chief reasons which have been advanced for the remarkable freedom in hospitals from the infection of attendants and other healthy persons, although they were in the midst of plague patients, and often in circumstances of close and prolonged contact with them, in all stages of the disease and in all varieties of it, are the absence of overcrowding, and the provision of adequate ventilation and light in the interior of the hospital wards. Those who have had opportunities of observing the relationships that are maintained between the patients and the attendant relatives

or friends can entertain no doubt regarding the intimacy of this relationship, for not 17,985.
only are they most assiduous in supplying the patient with food and drink, and in
assisting to change an irksome position, but saliva escaping from the mouth is often
removed by the hands of the attendant, and the hands are even used as a receptacle Vol I., Appendix
to receive sputum when the patient expectorates. XIV., p. 379.

31. It is no doubt the case that in many hospitals the risks of infection were attempted Absence of exten-
to be lessened by the use of disinfectants applied to the floor and walls of the wards, and sion in hospitals
even to the excreta of patients, and, occasionally, also to their bedclothes and persons. not due to disin-
On the other hand, the habits of the patients render it impossible effectually to disinfect fection by chemical sub-
all the infective material proceeding from them; and disinfecting operations have been stances.
carried out in several of the few hospitals regarding which detailed information is 7022.
available, in only a perfunctory manner, while the freedom from infection in these 20,628.
hospitals has been as decided as in the hospitals where greater precautions appear
to have been taken. The Officiating Principal of the Medical College at Calcutta
stated in reference to the Medical College Hospital that the floors of the wards "are
washed twice a week and disinfectants are placed about, and disinfectants are put in
the pans in which the patients expectorate. There is also a solution of the disin-
fectant for the nurses, &c., but I do not know that they are invariably used. . . . 7083.
We placed the antiseptic solution in the spittoons, but the patients expectorate on 7085.
the walls and the ground and all over the place, so that one really cannot disinfect a
ward as well as one would like. These patients are often quite delirious, and,
therefore, did not expectorate where one wanted them to." He also stated, "I 7081.
have seen no cases of infection either among nurses or any other person from any
living cases of plague." In reply to the inquiry, "You said you had seen no cases
of infection from plague patients occurring in the hospital: do you use any anti- 6961.
septics in the wards, do the nurses wash their hands with antiseptics?" Major
Evans, I.M.S., said, "They certainly do not wash their hands each time they touch
or feed a plague patient. They have done their work very bravely, and, as a matter
of fact, I think they wash their hands very seldom while on duty." He further 6962
stated that the nurses "certainly have not taken any very great precautions."

The practice followed in the Daliawadi Plague Hospital at Baroda, where the Report on the
mortality, deducting deaths which occurred within the first 24 hours, was 59·7 per Working of the
cent., and therefore by no means high, is thus described by Dr. R. N. Jadhav: "After Daliawadi Plague
the removal of dead bodies from the rooms of the hospital, the floor was burnt with Hospital from 6th Oct. 1897 to
a layer of straw, and the walls scrubbed with coir and washed with lime mixed with 30th April 1898,
perchloride of mercury. This practice was invariably followed in the case of every p. 7.
death that occurred in the hospital, except when, on account of a large number of
deaths and a sudden rush of patients to the hospital at one and the same time, it
was impracticable to carry out all the details of disinfection." It need scarcely be
pointed out that the chemical disinfection employed in this hospital was probably
useless; as the disinfecting properties of the perchloride of mercury were destroyed by
mixing it with lime, while lime itself has very little bactericidal action on plague
bacilli, even in the improbable event of its having been applied before it had absorbed
carbonic acid. As already stated (para. 27), there was, however, no extension of
plague among the members of the hospital establishment, and almost none among
the numerous attendant relatives and friends of the patients.

32. In corroboration of the independence of immunity in hospitals on disinfection by
chemical substances, the following evidence given by Captain Childe, I.M.S., regarding
the Jamsetjee General Hospital, Bombay, may be quoted: "I understand that you
said infection did not spread in your hospital when you had plague patients in 1516.
it: were the urine and the fæces disinfected, or was the fact of non-infection the
result of light and air?—In these early cases no precautions were taken at all,
because they were not diagnosed; but still no spread occurred. At the beginning
of the epidemic, cases were admitted before buboes appeared, and they might be
there two or three days in the hospital before they were diagnosed at all. They
were mostly admitted into the best wards of the hospital."

Plague patients, who were not known to be suffering from plague, were admitted into 6777; 6787;
other general hospitals, especially at the early stage of outbreaks, and, nevertheless, 7102-10; 7123;
although no special precautions were taken, the disease was not communicated to 7129-32; 7136-7.
other patients or to the ward servants or members of the hospital staff. A prominent
example may be cited of a patient who was treated in the Medical Cottage Hospital,
Calcutta, as a case of simple pneumonia, whereas it was shown at a *post-mortem* 6764.
examination that the case was actually one of plague pneumonia.

No extension of plague when patients treated in their own residences if in well-ventilated rooms.
22,510–14.
Snow's Report, p. 174.

33. Further, in several private houses, patients have been treated in well-ventilated rooms without the use of any chemical disinfectants, and still plague has not extended to the inmates of the house. This was done, for instance, by Captain Thomson, I.M.S.: "The room in which the patient remained was plague-proof, as I call it, and no case followed. . . . There were five other members of the family, and they were allowed to remain in the house. The house was well ventilated and not overcrowded. There were no chemical disinfectants, but the house was disinfected with sunlight and air." None of the other inmates of the house were attacked. This procedure was also adopted at Bombay, in the municipal chawls occupied by the scavengers and balalkhores. The few persons who became affected with plague in these chawls were allowed to remain in the rooms they usually occupied, or, in one or two instances, were transferred to rooms at one end of the building they lived in, "and their friends came to see them and went away as they liked." The result was perfectly successful, for very few cases occurred in these chawls, as they were sufficiently ventilated, although there were on an average seven persons in each room, and one of the chawls contained 800 people and was situated in Kamathipura, "in the midst of the most affected area."

Plague does not much extend in ships.
745.
753.
12,244, 25,496.
759, 763.
Chapter III., para. 256.

34. It is also a noteworthy circumstance that only a very small number of persons have become infected on board ship, even in vessels starting from plague-infected places. The number of these vessels and of their crews and passengers has been very large, 87,571 vessels having been inspected for plague at Bombay alone, between 1st January 1897 and 30th November 1898, with a total of 1,519,135 of crews and passengers. Yet, as we have elsewhere stated (our Report, para. 693), we were able to obtain information of only 30 cases of plague having occurred on board ship, which were distributed over 13 vessels of large size, six being mail-carrying steamers, one a troopship, one a ship having 1,021 pilgrims on board, and one a steamer conveying a large number of emigrants to Uganda, and bearing a crew of 100 officers and men. In thirteen vessels, therefore, cases of plague occurred while the ships were at sea; and, notwithstanding the fact that there was a large number of persons on board the ships to whom plague might have been communicated, only a most insignificant number of cases occurred. Further, in two of these vessels there were fatal cases, one of which, registered by the ship's surgeon as a case of plague, also suffered from acute pneumonia, and in at least two of the vessels dead rats were found. It may be assumed that this striking immunity can partly be explained by the favourable conditions existing in ships for the early discovery of cases of important illness; but, on the other hand, the conveniences for the separate treatment and complete isolation of infectious patients and the possibilities of disinfection by chemical substances must, necessarily, have been restricted, as we have pointed out in our Report. One condition of existence on board ship, however, cannot be ignored, namely, the provision of a good supply of pure air, which is secured not only by the regulations for preventing gross overcrowding and ensuring sufficient ventilation in the sleeping quarters, but also by the open-air life of everyone on board.

This absence of any marked tendency on the part of plague to spread in ships contrasts favourably with the rapid spread in badly ventilated houses on shore, and also with the instances in which on board ship the extension has been great and rapid of other infectious diseases, such as small-pox, yellow fever, measles, scarlet fever, and influenza.

Occupation during the night of infected houses which are inadequately ventilated is a potent cause of extension of plague.
1439; 21,538.
Inglis' Report, p. 15.
6007–9.
11,324–5; 11,433.

35. Infective material, apart from an infective person, may be present in a house, as in the floor, walls, or ceiling, or in articles contained in the house. It has been shown by the evidence that while the infectivity of this material is augmented by insufficiency of light and air, it may remain only slight when this insufficiency is not specially in operation.

36. Thus, in many places, evacuation was accompanied with the granting of permission to return from the camps to the evacuated towns or villages for the purpose of carrying on business or trade, and this policy, although obviously attended with some risk, appears to have been carried out with nearly complete impunity so long as the visits were restricted to the day-time, and did not involve the removal of articles of clothing or foodstuffs. Mr. Giles and Colonel McCloghry told us that at Karachi the people in the evacuation or health camps were permitted to go as they liked to the city during the day, and that the results in the camps proved that no harm resulted; and in General Gatacre's Report it is stated that when 400 of the inhabitants

of Worli Koliwadi were in camp, many of them went daily to the incompletely evacuated village to get grain, but no cases occurred in the camp after "the ten days' incubation period," although the type of the disease in the village was one of "extraordinary virulence, over 90 per cent. of the cases dying, often after a few hours pp. 187–9.
illness only."

37. This was not the case, however, when the visits were made surreptitiously, as they occasionally were, and the visitors remained and slept in the houses. For instance, at Malegaon, after all the houses had been disinfected with either perchloride of mercury or sulphuric acid, a number of persons from the evacuation camp were allowed to return to the town during the day-time for the purpose of continuing their work as weavers, in open and selected shops. "There were a few cases of those people stealing into their houses at night, and it was among them we had 18,075.
further cases of plague." In Nasik, cases of plague were constantly occurring in the camps, and this could only be explained, according to Mr. Silcock, I.C.S., by 13,807–8.
people returning secretly to their houses and sleeping there; while it was found that no infection appeared to be caused by allowing people to return to their houses during the day to "open their shops, do their ordinary work and carry on their trades," so long 13,809–12;
as they did not remain at night in shut-up houses. 14,733–5.
Further, Mr. Maynard, M.R.C.S., observed that several cases occurred after evacuation, because people could not be altogether kept out of their houses at night when the nights became cold. After the town of Ankleshwar had been evacuated in August 1898, many of the people in the 14,222.
camps were permitted to return to the town to transact business during the day, 14,226.
and beneficial results were not thereby prevented from following the evacuation. 14,408–9.
Although precautions were taken to prevent the people from remaining and sleeping 14,229.
in the houses at night, several of them secretly did so and became infected with plague. 14,230.
In a health or evacuation camp at Bombay, under the charge of Mr. F. M. Gibson, B.Sc. 17,295.
in Public Health, in which the inhabitants, averaging 500, were allowed free ingress and egress during the daytime, the only plague cases that occurred, excepting among those who had been less than ten days in camp, were in people who were distinctly known to have slept outside of the camp.

38. Individual instances have also been narrated. Dr. Petigara stated that several had come within his knowledge at Ankleshwar, even in houses that had been carefully disinfected with perchloride of mercury. He described the case of a policeman who, after the police lines had been removed to new quarters on account of an outbreak of plague, and while no further cases were occurring in the new quarters, visited and slept in a house in the vacated lines, contrary to orders and to the advice of his friends, 14,412–4.
"with the result that he soon acquired plague and died." Colonel Hutcheson, I.M.S., and the officiating Commissioner for the Nagpur Division of the Central Provinces have reported that after the town of Wardha, at the end of December 1898, had been Report on Plague and Plague Operations in the Central Provinces, pp. 12, 13.
completely evacuated and the houses disinfected, two cases of plague occurred early in January 1899, in persons who had evaded the guards and slept in evacuated houses in the town. Captain Walton, I.S.C., considered from his experience in the Cantonment of Ahmednagar, that one of the requirments for success in evacuation was 24,197–8.
always to make the people sleep in camp, although they may be allowed to go to the city during the day for business. He instanced the case of a man who became infected with plague because he slept in the city, although he had been strongly enjoined not to 24,155.
do so. Mr. Sladen stated that the system adopted in the Karachi Evacuation Camps was to allow the people to return to city in the day-time for their daily work, but to 12,752–3.
prevent them from living in the city, and that evacuation with this privilege proved successful in so far as the disease did not extend in the camps. He specifies an 12,755.
instance, in which the regulations were evaded by a man who went back to his house at night and slept there, with the result that he became infected and died of plague. 12,795–8.

39. On a larger scale, the evil effects of prematurely occupying and remaining all night in evacuated houses have been exemplified in several instances. Some of them, as that of Bantwa and Chak Kalal, and of villages in the Sirohi State, have already been referred to by us; and to them may be added the three following, which occurred Chapter VI., para. 632.
in villages in the Cutch State and in Kumaun, where it is notorious that the houses are badly ventilated and overcrowded.

The villagers of Salaya, who had been removed to huts on the sea-shore after ten cases of plague had been discovered in the village, and had had only one case while in camp for seven days, returned to their houses in the village because of a gale of wind, 13,431.
and during the two months they remained in the village, 102 cases occurred among them. Bada, also a village in the Mandvi District, was evacuated, and after the people had remained free from plague for 17 days in the evacuation camp, they were allowed,

13,456. on the occurrence of rain, to re-occupy their houses for four days; and immediately on returning to the evacuation camp several of their number became affected with plague. After forty-four cases of plague had occurred in the two adjoining hamlets of Bintola and Balt, in Kumaun, and the disease had been suppressed by the people removing to huts of grass and tree-branches on the hill-side, a snowstorm caused them to re-occupy their houses, and within a few days, four deaths from plague took place; but the outbreak was again suppressed when the villagers a second time sought refuge in huts. Evidence, Vol. II. Appendix XXV., pp. 337-8.

That conditions favourable to the propagation of plague are produced within native dwellings by circumstances connected with their habitation during the night, has also been exemplified in a case described by Major Hyde-Cates. Although the fishermen and sailors, who constitute the greatest part of the population of Salaya, were all day occupied in fishing or otherwise exercising their calling out-of-doors, they suffered severely from plague before the village had been completely evacuated. They, however, "sleep in their houses at night, and it may be noted that the houses are very dark and ill-ventilated, though clean." 13,476. 13,477.

To the same effect was the statement of Mr. Dhurandhar that, in Baroda, the plague incidence increased when the wind had an easterly direction, and diminished when it changed to the west, and that during the former people crowd into their houses; and that of Mr. C. C. James, that in Bombay northerly and easterly winds had, often immediately, an unfavourable influence on the mortality of plague, because, being cold, they drive people into their houses. Instead, therefore, "of a large number of people sleeping out-of-doors, as is generally the case during the hot weather, they all sleep in-doors, and, moreover, they shut their doors and windows. It is calculated that, in Bombay, 350,000 people sleep in the streets here during the hot season." 15,244-6. 26,104.

The prevailing opinion among those who have had the largest experience of plague has been expressed by Mr. Winter, I.C.S., who, in reference to the relative unimportance of the outbreak of plague at Kankhal during the hot and dry weather of May, stated that it was unlikely that plague should then spread rapidly, as "the people are sleeping out-of-doors all night, and they are probably out in the air all day," scarcely using "the interior of their houses at all;" and by Dr. Watson, who from his observations at Garhwal and Kumaun, where, as we have seen, the condition of the interior of the houses is eminently unsatisfactory, concluded that "it is almost certain death to sleep in the same room as a person who is suffering from plague." 9071. Vol. II., Appendix XXV., p. 363.

40. This great liability to become infected by remaining during the night in insufficiently ventilated chambers containing infective material—which in some of the instances cited, appears to have been reintroduced into disinfected chambers after their evacuation, by the entrance into them of plague-infected rats—contrasts in a remarkable manner with the immunity enjoyed by members of the same classes of people when they remain, as attendants on plague patients, even during many successive nights, in the well-ventilated, or it may be only fairly well-ventilated wards of a Plague Hospital, notwithstanding that the wards contain large numbers of infectious persons (paragraph 27, *ante*).

Comparison as to the incidence of plague between sanitary and insanitary towns, and between sanitary and insanitary houses in the same town.

41. This evidence would be strengthened if, on a comparison between a town in which the sanitary conditions within the houses were satisfactory with one in which they were not satisfactory, while the other chief circumstances that are known to modify the course of an outbreak were much the same in both towns, it were found that, on plague being introduced into each of them, it failed to produce a serious outbreak in the former, while it succeeded in doing so in the latter.* The possibilities of instituting such a comparison are extremely restricted on account of the difficulty of finding any native town with satisfactory sanitary conditions in which plague has occurred.

Contrast between outbreaks of plague in Hardwar and Banga. 9004-15.

42. Hardwar, however, is one of the few towns in which this requirement is fairly well obtained. Much attention is continuously given to its sanitation on account of the risks of outbreaks of infectious diseases which are incurred by the large number of pilgrims who periodically visit the place. The houses are well built and fairly well ventilated, and overcrowding is prevented by regulations and by frequent

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* It would obviously be futile to institute a comparison between any two places in which the more important of these circumstances were widely dissimilar, as, for instance, between Calcutta and Bombay, or between Bangalore and Mysore City, or between Hong Kong and Canton.

inspections. While the town contained a population of from 4,000 to 5,000, a plague 9,024.
case was discovered on the 8th of April 1897, but there was "very conclusive 9003.
evidence" that several cases had occurred prior to this date. After the 8th of April, 8908; 8912;
isolation of patients, disinfection, and several partial evacuations were carried out, and 9025; 9028.
the outbreak terminated, without complete evacuation having been required, on the 9029–38.
8th of June, or about two months after its commencement, during which time only 18 9041.
cases occurred, representing ·45 per cent. of a population of 4,000, or ·36 per cent. of 9058.
a population of 5,000, and, therefore, scarcely deserving to be termed an outbreak.

To institute a comparison with another town it would be desirable that that town
should be of about the same size, that the outbreak in it should occur at the same
period of the year, viz., during the warm weather, and that the chief suppressive
measures should be similar in kind to those adopted at Hardwar. These conditions
were complied with in the town of Banga, which is also situated in the Punjab,
and has a population of 4,727. The references to it in Captain James' Report and Captain James'
Evidence show that it also supplies the remaining requirement for a comparison with Report, p. 29.
Hardwar, in so far that the sanitary condition is in much the same unsatisfactory state
as that of nearly all the towns of India, and that the houses are insufficiently ventilated. Captain James'
The first case of plague occurred in this town on the 11th of March 1898, and the Report, p. 30;
outbreak continued until the 20th of June; and during these three months there were 10,235; Vol. II.,
103 cases and 65 deaths, making a percentage of 2·2 attacked, with a case-mortality p. 100; 10,373.
of 63·1 per cent. During this time, also, the patients and contacts were isolated, the Captain James' Report, p. 34.
houses were disinfected, and nine separate partial evacuations were carried out as Captain James'
soon as plague appeared in non-evacuated areas; and although extreme precautions Report, p. 32.
were taken to isolate these areas, the extension of the disease was checked only when
complete evacuation had been effected.

In two towns, therefore, of nearly the same size and situated in the same part of India, in both of which outbreaks occurred in the warm weather, and were treated with much the same measures, excepting that they were carried out with exceptional precautions and to a greater extent in one of them, the outbreak was much less severe and shorter in duration in the town in which the sanitary conditions of the interior of the houses were exceptionally satisfactory than in the town in which they were of the unsatisfactory character prevalent in India, although in the former the suppressive measures were initiated later in the outbreak and were less completely carried out than in the latter.

The comparison fails in one point only in each town. In Banga prophylactic Captain James'
inoculations were commenced at the beginning of the outbreak, and 865 of the Report, p. 133.
inhabitants of the town were inoculated; but Hardwar did not have this advantage,
as all of its inhabitants remained uninoculated throughout the whole of the outbreak. 9063; 9210.
In Hardwar, on the other hand, no plague-infected rats were seen, whereas in Banga 8913; 9448.
they were present in small numbers during the outbreak. This circumstance, however, Captain James'
does not materially affect the comparison, as no diseased rats were found in Banga Report, pp. 30–34.
until several indigenous cases had already occurred, and until nearly three weeks after
the discovery of the first plague patient. It is highly probable that in Hardwar the 10,235.
conditions unfavourable to the serious extension of plague among human beings also 1447.
prevented its extension among rats.

43. An instance may, however, be given in which, notwithstanding careful searchings,
so few dead rats were found that the possibility of the outbreak having been increased Contrast between
by them cannot reasonably be entertained. Rohri, a town in Sind, north of Hyderabad, outbreaks of
received several imported cases in February, March, and April 1897; and, although plague in Hardwar
some of them were not at once discovered and isolated, it is believed that no local and Rohri.
case occurred until the 17th of April. The outbreak then extended, and it continued 12,026.
until the 30th of June. During this time, representing the hot season, the plague
measures adopted were isolation of the sick and the contacts, and numerous partial
evacuations of blocks of houses in affected areas, with their disinfection by exposure 12,032; 12,041.
to sunlight and air and with perchloride of mercury. 151 cases in all occurred, or
129, if the imported cases are excluded, the latter being equivalent to 3 per cent. or 2·58 12,043–4.
per cent., respectively, of the estimated population of from 4,000 to 5,000. Although the
godowns and houses were carefully searched and everything done to discover infected
rats, only six were found; and Mr. Mountford, I.C.S., Assistant Collector, was able to 12,057–8.
assure himself that there was "no mortality among the rats." The sanitary condition
of the town was very unsatisfactory. There were many high houses in narrow streets,
the conservancy was greatly neglected, and the houses were badly lighted and 12,049.
ventilated.

The conditions as to the season when the outbreak occurred and as to the measures adopted and the absence of any influence produced on the extension of the disease by rats are, therefore, comparable with the conditions in Hardwar. The sanitary state of the buildings was, however, markedly different in the two towns; and in the town where the dwellings were badly ventilated and lighted, the incidence of plague was about six times greater than in the town where the state of the dwellings was relatively satisfactory.

44. While in the prevailing insanitation of the plague-infected towns and villages it is extremely difficult to obtain examples of towns or villages where the sanitation is in a sufficiently satisfactory state to institute comparisons such as have been made, the object of the comparisons may equally be attained by contrasting in the same town or village the incidence of plague in well-lighted or well-ventilated groups of houses with the incidence in houses which are inadequately ventilated and lighted. This has already been done, but for other purposes, in many of the preceding paragraphs, and especially in those in which attention has been drawn to the freedom from infection of the occupants of houses in the European quarters of plague-infected towns, and of the occupants of sufficiently ventilated and lighted chawls and other Native houses situated in the midst of plague-affected insanitary houses (paragraphs 10 and 15).

Results of geological and meteorological investigations support the view that conditions inside of houses are the dominating factors in the propagation of plague.

45. That the predominating factors in the extension and virulence of plague are to be found in the interior of the dwelling-houses is also indicated by the results of investigation into the relationship between the incidence of plague on the one hand, and the geological character of the soil and the conditions of climate on the other hand.

46. The former subject may be briefly considered. Professor Griesbach, Director of the Geological Survey of India, informed us that "so far there is no evidence that plague could be specially generated by any of the formations in India," for, although the soil of the affected districts is chiefly derived from trap and crystalline rocks and, to a less extent, consists of alluvium of unknown depth, the disease has spread from Bombay over such a fan-shaped area as it would naturally cover were human communication the main agency in its extension; while, looking outside of India, the broad statements may also be made that the plague "occurs practically in all soils," and "that the disease is primarily a soil disease is certainly borne out neither by experiment nor observation."

8311, 8315, 8327.

Lowson's Report, p. 9.

Relationship between climate and plague.

47. In regard to any relationship that may exist between variations of climate and variations of plague incidence, we have had before us the views of three authorities on the subject.

Dr. Moos, the Director of the Government Observatory at Bombay, concluded from his investigations that the maximum mortality from plague in that city coincided with the periods when the ground evaporation was greatest.

20,301.

Dr. Buchan, F.R.S., dealing chiefly with Professor Moos's figures, points out that in Bombay there are two annual maxima in the plague mortality: one—and much the larger—which occurs during the coldest and driest weather, and especially when the cold is greatest at night, from January to March; and another which occurs during the wettest and still very warm weather, from August to October. "The larger maximum," he remarks, "is practically coincident with the coldest weather of the year, and such weather, particularly during the night, and, considered in connection with the habits, housing, and clothing of the population, may perhaps account for a part of the great mortality." He considers that the mortality curve does not coincide with the temperature of the air, humidity, temperature of the soil, rainfall, or any single meteorological element taken by itself, but that a curve of agreement may be obtained by calculating the difference between the temperature of the soil 5 feet below the surface and the temperature of the air over the soil, plague being most prevalent when the temperature of the ground-air is the highest above that of the super-natant air. Both Professor Moos and Dr. Buchan appear to consider that plague increases in direct ratio with the increase in the conditions favouring the exit of air and moisture from the ground, and therefore of the exit of any noxious substance contained in that air.

Evidence, Vol. III., Appendix LVIII., pp. 437-9.

20,308.

Professor Hunter Stewart has dealt with the subject from the broader standpoint of the climatic conditions of all parts of India affected with plague. He considers that when the atmosphere has its minimal drying power the plague incidence is least, and that as the drying power of the atmosphere increases the plague incidence also increases, until the soil has finally become so dry that bacterial growth is checked, and then the plague incidence greatly diminishes or altogether ceases. One of the most important statements in his Report, harmonizing with the views of Dr. Moos and Dr. Buchan, is that: "When the temperature of the soil at (say) 5 feet is higher than the temperature of the atmosphere, the gases in the soil, pressed on by the colder and heavier gases above, escape at places where there is least resistance." Such places, he points out, are found in the earth-floored houses of the natives, especially during the night and in the cold seasons, for then the outside air is coldest, and therefore heaviest, and it exerts a greater pressure on the air of the soil, while on the other hand the air in the houses is at its warmest and therefore lightest, and favours the rise of ground-air into them. As, however, the maximum velocity with which the ground-air can diffuse into the atmosphere is only slight, the detachment of micro-organisms from the pores of the soil is, in his opinion, impossible, and therefore any noxious substances which are thus carried into the atmosphere must be volatile, and would act only as predisposing causes of plague.

"Rainfall *per se* seems to have little, if any, effect on the epidemic *appearance* of plague." On the other hand, the severity of an outbreak is increased by the occurrence of heavy rains, as was illustrated in the Karad villages in 1897, in Poona in 1897 and 1899, and in Belgaum in 1898 and 1899. He thinks, however, that "this effect of rainfall is probably to be explained as resulting from the impossibility of securing efficient evacuation of houses during heavy rains. There is either no evacuation at all, or all openings for ventilation in the huts at the evacuation camps are closed up on account of the rains. The bad hygienic conditions which, from the evidence, seem to be a most important factor in the epidemic occurrence of plague, are thus continued in the camps."

The following conclusions have been arrived at by Professor Hunter Stewart:—

"(1.) That in the areas affected by plague the temperature conditions are suitable for the epidemic appearance of plague at all seasons.

(2.) That the amount of moisture in the atmosphere has little if any influence.

(3.) That the rainfall seems to exert its effects chiefly or entirely by interfering with remedial measures."

48. It would appear, therefore, that geological formation has no obvious influence upon plague extension, and that the variations in climatic conditions encountered in India have only a slight effect; but, in so far as that effect is operative, its influence is prejudicial in the interior and not the exterior of dwellings.

Cyclical character of successive local outbreaks not explainable by temperature or rainfall.

49. During the four years that the present epidemic has continued in India, one of the most striking facts which has distinguished its history is the cyclical character of its annual increase and decrease. As these cyclical variations are unexplainable by lowness of temperature or severity of rainfall, corroboration is given to the view that they are usually dependent upon the increase of the insanitary state of the interior of dwellings resulting from their being occupied by larger numbers of inhabitants, and from the greater prevention of ventilation by the closing of external openings, during the cold and wet seasons than at other times of the year.

As already indicated in paragraph 47 of this Memorandum, and in paragraphs 327, 332, 334, 335 and 375 of our Report, in Bombay and elsewhere in India plague has displayed a growth and decline which have recurred with singular regularity during each year of the epidemic; the maximum mortality having been attained in the cold weather, and a second but much smaller maximum in the rainy season. If these maxima, representing cyclical recrudescences, are caused by the conditions produced within dwellings by their being occupied by larger numbers of inhabitants during cold and wet weather than at other times, it is almost superfluous to point out that each recrudescence of plague mortality would be gradually and not abruptly produced, and would not, indeed, be conspicuously manifest until several weeks had elapsed since the advent of the cold and of the wet seasons, respectively; and this feature has been clearly displayed in the outbreaks in Bombay and in other places. (*See* Charts, Evidence, Vol. III., p. 439, and our Report, paragraph 322).

It is, however, well known that there have been many exceptions to this annual cyclical growth and decline and to the occurrence of the chief outbreaks in the cold and the wet seasons. Plague has, for instance, been most prevalent in several villages in the Satara District during heavy rains; in the towns and villages of Sind and Cutch it has been most severe during hot and dry weather, and in the Cutch Territory it has also displayed a further irregularity by devastating the town of Mundra in the cold

22,737.
18,143–4;
18,441–3; 22,423;
27,146.
13,485; 27,028;
Vol. II., Appendix XLVII.,
pp. 476–7.
6166.

weather; in successive outbreaks at Poona and at Karachi, it has attained its maximum development in one year in hot and dry, in another in hot and moist, and in a third in cold and dry weather; while in the mountainous elevations of Kumaun and Garhwal, it has spread in the villages and hamlets chiefly during the ice and snow of winter.

26,342.
27,377-9; Centralblatt für Bakteriologie, 1898.
26,342.
Die Einwirkung der Winterkälte auf die Pest- und Diphterie-Bacillen; Centralblatt für Bakteriologie, 1899, p. 182.

50. It is obvious, therefore, that the occurrence and extension of plague are independent of climatic conditions. Nevertheless, the plague bacillus thrives best at a temperature of about 37° C. (98·6° F.), and it requires moisture for its existence and growth. It is killed in from five to ten minutes by exposure to a heat of 62° or 63° C. (143°—145° F.), and in from one to two hours by exposure to 50° C. (122° F.); and even the highest of these temperatures is considerably below that of the sun's rays in many parts of India. Its growth is greatly retarded when, even in a moist state, it is exposed to sunlight; and, as it perishes in less than four hours when thus exposed, the duration of its life must be much briefer in the open air, under the aided influence of desiccation and of free oxidation in intense light. It is also devitalised, so that both its pathogenic power and its vegetative activity become much reduced, by exposure to cold, and it would be brought under the influence of very low temperatures during the rigorous winters of Kumaun and Garhwal.

51. In those parts of India, therefore, in which plague has been prevalent, the plague bacillus, except in narrow lanes and overshadowed courtyards such as are numerous in Calcutta, would be unable to maintain its existence for more than a brief period on the surface or at a short distance below the surface of the ground in the open air, and could do so only where it is protected from the destructive influences of climate. This protection can be obtained in the interior of dwellings, and there also the warmth requisite for the active vitality of the bacillus is secured when the temperature is either too high or too low outside of the dwellings, and the requisite moisture is provided when in the outside air the bacillus would be killed by desiccation. Excess of moisture, such as that of the ground in the rainy season, is likewise destructive to the bacillus; nevertheless outbreaks which had become dormant in the preceding hot weather acquire renewed activity during rains, and, as we find from the evidence, the people who then remain shut up in the houses during the day and night "with the windows and doors closed" suffer from plague, while the renewed outbreak does not involve those who remain much outside of the houses in order to follow in the open air such occupations as rice cultivation, hawking, and begging.

22,127.
22,184.
22,129.

Further, as has elsewhere been stated in this Memorandum, the influence of climatic changes has occasionally interfered with the almost unvarying success of complete evacuation, because of the indirect effect of climatic changes in causing people to leave the huts in the camps in order to shelter themselves in the evacuated houses; as in the declining outbreak at Nasik during the cold months of January and February, and in the town of Salaya, when the same interference was caused by a gale of wind. The influence of climatic changes has likewise increased the number of plague cases in a non-evacuated population, as when the temporary occurrence of cold northerly and easterly winds during the hot weather had prevented many people in Bombay from sleeping out-of-doors as they usually do at that time.

14,733-5.
13,431.

26,103-4.

Growth and decline of local outbreaks prove that spread and virulence of plague chiefly depend on insanitary conditions within dwellings.

52. There appears to be no satisfactory explanation of these regular and exceptional incidents in the history of the plague epidemic other than that the predominating factor in the extension of the disease is to be found in the conditions which exist within and not outside of the houses of those who have been the chief sufferers. Plague proves itself to be independent of climate, and independent because the temperature and moisture requisite for its active existence are provided within the houses of each place where it has established itself, and where also, as will afterwards be explained, the polluted atmosphere of the dwellings probably supplies further elements for its extension and increase in virulence. All the definitely ascertained facts appear to be in accordance with this explanation, and it is highly probable that were fuller information obtained regarding the exceptional cases of seasonal incidence they would be found entirely to accord with it, and to render unnecessary any theory of epidemicity (such as has been suggested in paragraph 384 of the Report), which is independent of temporary aggravations of air-pollution or of the accident of the time at which infection happens to have been introduced into, or to have been set free in, a place.

Influence of filth.
Para. 6, *ante*.

53. The value of the assertion that plague is increased by general insanitary conditions has already incidentally been considered, and the conclusions have been arrived at

that the influence of these conditions is a secondary one, and that plague cannot justly be regarded as a filth disease in the ordinary acceptation of the term. Filth even in this acceptance cannot, however, be altogether eliminated as a causative condition. In some form of it, it has been present wherever outbreaks of plague have occurred. The opinion of the few witnesses who have expressed themselves with some hesitation on this subject must be received with reservation, as, for instance, when we are informed regarding the generally wealthy Jains of Bombay, among whom the plague incidence and mortality were high, that the sleeping and cooking places in their houses are not very dirty and "look comparatively clean," while it is added that the Jains "will not sweep their staircases or sweep their sleeping rooms out, or their cooking room very often." Although it is sometimes found that the interior of native houses, even when constructed of the poorest materials, is in appearance clean and obviously suggestive of attention and care in preventing accumulations of filth, true cleanliness can never be obtained so long as the floor and frequently also the walls are saturated with moist and decomposing cow-dung, and so long as cattle are stalled in the dwelling-houses, and, as was observed during visits to several towns and villages, in central parts of the houses into which sleeping chambers had their only openings for ventilation, and in which the inmates of the houses even lived and fed and slept. Mere superficial cleanliness is, however, absent in the great majority of the houses, both in towns and villages; for, as it has been shown, their inside condition as well as their immediate outside surroundings are usually unsatisfactory, in an extreme and often an appalling degree.

5903.

17,681-2.

Snow's Report, p. 83; **7841; 15,182; 24,194.**

54. While there is no direct evidence that plague bacilli continue to exist or to proliferate for long periods of time in filth, there is much indirect evidence in support of their being able to do so, and it is to be borne in mind that experimental investigation, in so far as it has advanced, has not proved that this does not occur. The experiments with earth and cow-dung made by Hankin, Gibson, Marsh, and others have no doubt failed to discover a prolonged existence of the plague bacillus in these substances when non-sterilised; but the failure appears to be mainly due to the absence of any known process for their identification by culture or microscopic examination, caused chiefly by difficulties in the separation of plague bacilli from the numerous contaminating saprophytic micro-organisms always present in earth and cow-dung. If these organisms exert an injurious action upon the vitality of the plague bacillus, they would do so by the poisonous action of the toxins they produce, or by strangulation of the plague bacilli, or by exhaustion of the food on which they subsist. Captain Spencer, R.A.M.C., however, has shown that the fluids in which a large number of the organisms found in earth and cow-dung had been separately grown, and which, therefore, may be assumed to contain the soluble toxins produced by them, failed to cause any obvious deleterious influence upon the vitality of the plague bacillus. Further, in the large mass of matter constituting the earth or the cow-dung or other organic filth in which plague bacilli would be found in nature, it is improbable that their existence could soon be terminated by strangulation from an excessive growth of co-existing micro-organisms, or by starvation resulting from exhaustion of nutritive material by other more actively vegetating micro-organisms.

8509; 8511; 18,867; 18,880. Campbell's Report, pp. 211, 619-13.

18,867-8.

211,619-633.

8509-14; 8522, Vol. II., p. 10; 18,867-8; 26,398.

26,150.

55. While, however, the vitality of the plague bacillus is certainly retained for considerable periods of time in earth and cow-dung and other filth, it is equally apparent that its vitality is lessened and even destroyed by free exposure to air and light. The evidence brought before us indicates that in many places those persons who by their occupation are brought into the closest association with night-soil and other filth have not been much affected by plague; but it is not to be overlooked that this association with excremental matter occurs for the most part in the open air, and, also, that the occupation of these people requires them to live much out-of-doors. Further, excrement, even when derived from plague patients, cannot frequently contain plague bacilli, and never in more than minute quantities; as plague bacilli are not present in the excremental discharges during the whole period of illness, but only a few hours before death, and even then in but small numbers.

Vol. I., Appendix XIV., p. 378; 22,266-9; **R. N. Jadhav's Report,** p. 15.

24,054-7.

A portion of Lieut.-Colonel Weir's evidence on this subject is highly significant; for he stated that while the scavengers and sweepers who lived in well-ventilated and lighted municipal chawls suffered to only an insignificant extent from plague, even although the chawls were situated in the midst of plague-affected districts, many cases, on the other hand, occurred among the scavengers and sweepers who lived in the ordinary native houses.

Snow's Report, p. 174, **para. 621.**

Irrespective, however, of the protection afforded by air and light in open places, it is improbable, for reasons that have been discussed, that the plague bacillus could retain its vitality for longer than brief periods of time on the open ground outside of houses, whether in an ordinary or in a sewage or excrement polluted soil.

23,191–6.

56. On the other hand, filth inside of or in close proximity to dwellings has a detrimental influence by increasing the vitiation of the atmosphere of the dwellings, and, possibly also, when it is present within houses, by supplying nutriment for the growth of the plague bacillus. It thus adds to the conditions within the dwellings that are favourable to the vitality and virulence of the bacillus and are unfavourable to the health or powers of resistance against infection of the inmates of the dwellings.

57. While, however, filth, either within or in the neighbourhood of dwellings, increases the spread of plague, the conditions that otherwise exist in the great majority of native houses are so powerfully favourable to the propagation of the disease, that it may well happen, as several witnesses have pointed out, that plague has occurred and on rare occasions, even spread to a slight extent in houses which are clean, in so far as obvious and superficial uncleanliness is concerned. It is apparent, also, that the absence of filth and of the other conditions referred to cannot absolutely prevent the occurrence of an infectious disease, however much their absence may diminish the occurrence and, above all, lessen the extension and virulence.

Overcrowding chiefly operative by increasing the vitiation of the atmosphere within houses.

58. As we have seen, overcrowding is stated to be one of the most frequent of the causes of vitiation of air in the dwellings of natives of India. A common, but not a necessary, incident of overcrowding, if it occur in proximity to infective persons or materials, is that it increases the number of persons subjected to the risks of infection. It may, therefore, be supposed that the undoubtedly predominating influence exerted on the propagation of plague by conditions so frequently existing within dwellings is capable of sufficient explanation from the circumstance that the plague virus is given the opportunity of infecting a larger number of persons in an overcrowded place than in one which is not overcrowded.

59. This resolves itself into the propositions that the extension of plague in a place which contains infective material is mainly caused by the opportunities for infection afforded by there being a large as contrasted with a small number of persons in the place, and that the extension is caused only to a slight extent, if at all, by the vitiation of the atmosphere and other conditions which result from overcrowding. When these propositions are examined, they are found to have no foundation in fact.

Almost no infection when exposure is in open air.

It has over and over again happened that people brought into the closest proximity to plague infection in the open air have so seldom been affected, that the circumstance has attracted general interest. In Bombay and other plague-infected cities and towns, a large proportion of the inhabitants have, in accordance with a prevailing custom, slept in the streets and courtyards, often in such numbers that thoroughfares are actually obstructed by rows of human beings lying close to each other, and the presence of plague-infective matter has been demonstrated by the occasional discovery of a dead body in the early morning; but so few cases have occurred among them, that the decadence and cessation of outbreaks in the warm weather has very commonly been explained as a result of this custom.

Jadhav's Report, p. 15.

Snow's Report, p. 107.

Many European and other official and volunteer plague workers have, day after day, exposed themselves to infection in superintending and taking an actual part in the removal of plague patients and dead bodies, and in attending plague patients in hospitals and private houses; and the incidence of plague among them has been so small as to be almost incalculable.

Almost no infection when exposure is in well-ventilated places.

Even in enclosed spaces, people have freely associated with plague patients, and have been in proximity with infective material, without succumbing to the disease, provided the enclosed spaces were not inadequately ventilated. A large number of illustrations of this have been given in the preceding pages. Reference may be made to the experience of physicians, nurses and attendants in hospitals; to the free association with impunity between plague patients and their relatives and friends in well-ventilated municipal chawls in Bombay; to the remarkable freedom from plague on board ship, even when a large number of persons have been confined in a limited space, containing the most infectious form of plague; and to the instances that have been recorded of policemen, sweepers, and tramway men in Bombay, who, while following their several occupations during plague outbreaks, were necessarily brought into daily

Snow's Report, p. 146, para. 565.

contact with plague infection, but suffered little from the disease so long as they lived, during the night, in houses where the atmosphere was not polluted by the accumulated exhalations from human beings and from decaying organic matter.

Infection promptly produced in badly ventilated places.

60. If, however, plague-infective material be allowed to operate in confined spaces containing an atmosphere rendered impure by defective ventilation, experience has shown that the infective matter then actively asserts its disease-producing power. This has abundantly been illustrated in the prevalence of plague in the usual unventilated houses of natives; in the failure of health camps to suppress the disease when the huts were "hermetically closed"; and in the disappearance of freedom from infection in dwellings that are insufficiently ventilated, among the members of the same bodies of policemen, sweepers and tramway men, as escape infection when occupying houses that are adequately ventilated. 11,971.

Mere number of people of much less importance than effects of bad ventilation.

61. It is definitely indicated by these and many other incidents brought under our attention, which have already been described, that the number of people contained in an enclosed space does not so much govern the infectivity of plague as the vitiation and other changes of the atmosphere, which may indeed be grossly produced by only two or three persons, although in any given enclosed space they are, no doubt, produced in a greater degree by a larger than by a smaller number of persons. It has not even been found that increased opportunities of infection are necessarily followed by an increased number of infections. An European living in Malabar Hill is no doubt exposed to fewer risks of infection than a Bhatia living in Mandvi, but so also are the occupants of a chawl in Kamathipura which contains 2,000 inhabitants than the dwellers in a suburban hut, accommodating only six or eight persons, and yet the incidence of plague has been greater in the latter than in the former. As we have already seen, in each of these cases, the larger incidence has been accompanied with the greater degree of pollution of the interior of the dwellings, resulting from inadequate ventilation. 17,691.

Overcrowding not co-relative with number of persons.

62. Overcrowding, however, is a relative term, and is not co-relative with any specific number, but with the number present in a given space and the efficiency of the ventilation of that space. In enclosed spaces of equal capacity, it may be produced by five persons, and may fail to be produced by twenty persons. A single individual in a small enclosed space, without sufficient means for allowing entrance and exit of air, would overcrowd that space, although there is no crowding together of people in it, and this single individual would, by vitiating the air, produce conditions specially favourable for the proliferation and virulence of any plague-infective matter that is present. This has frequently been illustrated in the history of evacuation, which has shown that the daily visits of people to recently evacuated and well-ventilated and infected places, such as to the open booths of bazars and even the opened-up living rooms of dwelling-houses, have not been followed by infection; whereas the surreptitious sleeping of a single individual in one of these booths or rooms, implying, in the existence of penalties for doing so, the careful closing of all external openings, has almost without exception been followed by infection.

Conclusion respecting overcrowding.

63. It is therefore apparent that the number of persons in an enclosed space, such as a dwelling-house or room, is mainly operative by producing conditions favourable to the proliferation and enhanced virulence of plague, and, according to the number of persons, of materially or immaterially adding to the detrimental conditions produced by defective ventilation; while the actual number of the occupants of the enclosed space has only the secondary importance of bringing a larger or a smaller number of persons within the range of infection.

Criticisms of statements relied upon to disprove above conclusion.

64. As this constitutes one of the fundamental conclusions relating to the influence of sanitary conditions with which, I regret, my Colleagues are not in agreement with me, the following observations may be made upon the statements relied upon by them. While admitting as a possibility that pollution of the atmosphere may have a fostering influence upon the spread of plague, they appear to consider that the conclusion at which I have arrived is inconsistent with the circumstance "that plague may occur in houses whose atmosphere is quite untainted" (Chapter III., paragraph 350). This circumstance, of course, is highly probable, for plague is an infectious disease. It is not, however, obvious that it possesses any value when used as an argument against the definite proposition that a polluted atmosphere within occupied dwellings has been in India the main cause of the spread and virulence of plague.

The only places cited by my Colleagues in which plague is believed by them to have occurred "in houses whose atmosphere is quite untainted" and "in well-ventilated and airy houses" are Hardwar, Karachi and Ahmednagar, and also "the lofty and, from every sanitary point of view, unimpeachable buildings of the Byculla Jail in Bombay." Descriptions of the condition of sanitation in the houses and buildings in each of these places have already been given in this Memorandum (paragraphs 2, 3, 7, 11, 42).

Hardwar is one of the few places whose sanitary condition is fairly satisfactory. It has already been dealt with (paragraphs 42, 43, *ante*) in order to show that plague does not extend in a town where sanitation has received careful and successful attention. The outbreak was an altogether unimportant one, and it contrasts most favourably with outbreaks in towns of similar size but with highly unsatisfactory sanitary conditions within the dwellings, such as Banga and Rohri, although the measures for suppressing the outbreaks in them were of the same kind as the measures employed at Hardwar.

On consulting the reference given as the authority for the above statements respecting Karachi (our Proceedings, 11,095), the only fact revealed is that the probable first case, that of a Brahman cook, occurred in a house "in quite a good street—a broad street"; but, unfortunately, these qualities are not inconsistent with the existence of the gravest air-pollution within Native dwellings. Mr. Giles, 11,096. who gives the information, immediately adds, "it was a curious thing if the first local case occurred here; local cases generally occur in the worst places." There is, however, nothing in the evidence to show that the house was "well-ventilated and airy," or that its atmosphere was "quite untainted." Both Mr. Giles and the Health Officer, Dr. Kaka, were of opinion that the disease had been imported from Bombay. Before this patient, who was suspected to have introduced the disease, had been discovered, he had been surreptitiously removed from Rampart Road, where he first became ill, into the City (11,846); and while, apparently, no cases occurred in Rampart Road, the broad and good street referred to, the disease gradually "laid a 11,848. firm hold of the City, raging in the form of an epidemic." Dr. Kaka also stated that in Karachi, plague chiefly occurred "in low, damp, dirty, and ill-ventilated places."

My Colleagues refer to No. 24,228 of our Proceedings as the basis of their statement regarding Ahmednagar; but it is not there affirmed that any plague case or cases occurred in "well-ventilated and airy houses," or "in houses whose atmosphere is quite untainted." On the other hand, it is rendered apparent from other parts of the 24,275. Evidence that, during the first outbreak, to which the reference relates, plague cases chiefly occurred in mud houses or huts where "there are very few openings for ventilation . . . if there are any they are very small." There was, however, a second small outbreak of plague in Ahmednagar, during which two of the earliest 24,276-7. cases occurred in "the Sisters of the S.P.G. Mission," after a good many rats had died in it; but there is nowhere in the Evidence any description of the condition of ventilation or any description of the relationship between the size of the living quarters of the Mission and the number of persons occupying them. The Chairman of the Municipality, whose authority has been appealed to in the above reference, 24,228. definitely mentions "want of ventilation" as one of the conditions most conducive to the spread of the infection. The houses are "so constructed that they have very 24,311. little ventilation, and even that is closed during the night. There are certain houses which even require a light in the daytime."

In regard to the occurrence of a considerable number of cases in the Byculla House of Correction, it has already been pointed out that overcrowding existed at the time of the outbreak (this Memorandum, paragraph 11). Nothwithstanding the great and predominating influence of a polluted atmosphere in fostering the extension and virulence of plague, it undoubtedly does not follow that when infection happens to be introduced into a crowded building, several or many of the inmates will not be affected if sufficient opportunity for personal infection has been given, even although no gross insanitary conditions are present.

The above examples, which have been cited in support of the statement that "plague may occur in houses whose atmosphere is quite untainted," therefore, not only fail in the purpose for which they have been cited, but actually constitute illustrations of the fact that, after plague has been introduced into a place, its extension and virulence are chiefly fostered by the pollution of the atmosphere and other conditions which result from the inadequacy of ventilation and sunlight, and from the uncleanness within and near dwellings, which characterise the great majority of Native houses.

V.—THE CONDITIONS WITHIN DWELLINGS WHICH INCREASE THE EXTENSION AND VIRULENCE OF PLAGUE, AND THE MANNER IN WHICH THEY DO SO.

65. If, in addition to the indications which have thus been supplied by experience, it should be rendered probable by experimental investigation, that the insufficient ventilation of a confined space containing infective matter and persons liable to infection is in itself productive of conditions conducive to the proliferation and enhanced virulence of the infective material, and to an increase in the susceptibility of individuals within the range of its action, further support would be given to the conclusion that the conditions produced by insufficient ventilation exercise a predominating influence. The experiments bearing on the subject may conveniently be next considered; but whatever value they may possess, the various facts and incidents which have already been brought forward point very clearly to plague extension, if not also plague virulence, being greatly dependent on conditions existing within dwellings, and, indeed, they appear sufficient in themselves to afford a complete demonstration of this dependence. In view of these considerations and of the circumstance that, unless in a badly ventilated chamber, infective matter, even when originating from the pneumonic type of plague, has not been found to be powerful in propagating the disease, the fostering conditions inside of houses assume the position of the highest importance. What they are and how they operate may now further be considered.

Experience has proved that insanitary conditions within houses are the chief causes of the spread and virulence of plague.

How far corroborated by experimental investigation.

26,715–725.

66. As is apparent from the foregoing, a singular unanimity has pervaded the evidence in indicating that the extension and probably the virulence of plague are chiefly increased by deficiency of light and of ventilation and the consequent pollution of air and other changes produced by them. Operating less generally, are also the conditions which originate from the special nature of the floors in a large number of the houses in which plague has occurred.

Conditions within houses that increase the infectivity and virulence of plague.

The effects produced by each of these conditions may conveniently be considered in regard, in the first place, to their effects on the plague micro-organism, and, in the second place, to their effects on the individuals subjected to their influence.

67. The action of direct sunlight on the plague micro-organism has frequently been examined, and, as we have elsewhere stated, (our Report, para. 658), it has been found that the organism is speedily devitalised by exposure to it. No serious attention has, however, been given to the action upon these organisms of obscured or indirect sunlight, for little more has been determined than that such light does not destroy this vitality under many days' exposure; and no accurate or detailed examination has been made of the effects of darkness upon them.

Effects on the plague micro-organism of deficiency of light.

These subjects have, however, been experimentally examined in regard to several other micro-organisms. It has been shown, for instance, by Dr. Downes and Mr. Blunt, that the retention of the vitality of bacteria is in accordance with the degree of obscurity of the light to which they are subjected, and this conclusion has been confirmed by M. Duclaux and by Professor Tyndall. The experiments of M. Duclaux have likewise shown that when they are kept in the dark, certain micro-organisms may retain their vitality for several years. As, also, it is in accordance with general observation that the vitality of micro-organisms is retained more certainly and for longer periods in darkness than in light, it cannot be doubted that darkness and, to a less degree, deficiency of light are conducive to the prolonged existence of the plague bacillus.

Proceedings of the Royal Society, Vol. XXVI., 1877, and Vol. XL., 1886.

Annales de Chemie et de Physique, 6me Ser., t.v., Mai, 1885.

68. The most readily appreciated elements constituting air pollution in dwellings that are insufficiently ventilated are diminution in the amount of oxygen, with increase in the amount of the carbonic acid, water and nitrogenous compounds derived from the lungs, and of water and nitrogenous compounds derived from the skin exhalations of the inhabitants of the house. Notwithstanding the many directions in which the bacteriological knowledge of plague is still imperfect, it is fortunate that sufficient work has already been done to indicate, and, indeed, to establish on the part of some of them, the manner in which these elements exercise a deleterious influence.

Effects on the plague micro-organism of deficiency of ventilation.

69. In common with all other disease-producing microbes, that of plague largely depends for the continuance of its existence upon moisture and warmth. In an occupied and insufficiently ventilated room, the former is abundantly supplied by the exhalations from the lungs and skin of the inmates, and the latter by the heat radiated from their bodies. Thus it happens that plague flourishes in India in all

The required moisture and warmth provided in unventilated rooms.

6166. conditions of climate, in the snowy altitudes of Kumaun and Garwhal as well as in the tropic heat of the plains, in the moist atmosphere of Bombay as well as in the dry and arid sands of Karachi. It is independent of outside and general climatic conditions, because it finds those elements of climate which are conducive to, or even necessary for its vitality and virulence, within the houses of the people in all places and seasons.

Deficiency in amount of oxygen is favourable to the vitality of the plague bacillus.

8552 (Evidence, Vol. II., pp. 8–10).

70. The conditions produced within the houses do not, however, merely maintain the existence and virulence of the bacillus. The defective supply of fresh air leads otherwise to important modifications in the composition of the air confined within the rooms. In the first place, the normal amount of oxygen is reduced, and the experiments of Mr. Hankin have a suggestive bearing upon this reduction. He found that oxidising agents rapidly killed the bacillus, and also that when the amount of oxygen in the atmosphere is reduced by an inert gas such as hydrogen, the bacilli resist the destructive action of desiccation for a much longer period of time than when desiccation is accomplished in an ordinary atmosphere. Further, in Mr. Marsh's experiments, plague bacilli were grown in air diluted with the inert gas, nitrogen, and therefore containing less than the normal amount of oxygen, with the result that the growth and reproduction of the bacilli were increased. Apparently, therefore, the vitality of the plague bacillus is enhanced when the amount of oxygen in contact with it is reduced within certain limits. 18,893.

Excess of carbon dioxide increases the proliferation and virulence of the bacilli.

71. The effect of a mere reduction in the amount of oxygen in the air, however, would appear to be surpassed when the reduction is caused by the presence of an abnormally large quantity of carbonic acid. During respiration, this gas is abundantly evolved into the expired air. About 17 cubic feet are given off by each adult in 24 hours, and therefore, about 5·4 cubic feet in the eight hours during which a Native sleeping chamber may be assumed to be closed to ventilation. While sufficient ventilation is maintained, an accumulation representing more than ·06 or ·08 per cent. is prevented; but the percentage of carbonic acid in the air of a sufficiently ventilated chamber must necessarily be much increased whenever both the exit and entrance of the air are prevented or are greatly reduced. Provided that by some special arrangement pure air were continuously supplied to the lungs, one person would in eight hours evolve sufficient carbonic acid to raise the amount of it to ·6 per cent., and four persons to 2·4 per cent., in a chamber 10 × 10 × 8ft. and, therefore, of the capacity of 800 cubic feet; and these percentages would be much increased were the chamber to contain a lighted oil lamp or candle. Further, the defective ventilation would lead to an accumulation of moisture and an elevation of temperature favourable to the evolution of carbonic acid from the organic matter abundantly present in the rooms of the great majority of native houses; and, as has been pointed out by the meteorologists, any carbonic acid thus generated in the earth of the floor would, by the pressure of the external atmosphere, be diffused into the occupied room along with the ordinary carbonic acid of the ground air, especially during the night and in cold weather.

18,893. In a well devised and carefully conducted series of experiments, Mr. Marsh, M.B., found that an atmosphere containing 3 per cent. of carbonic acid and 97 per. cent. of ordinary air at 80° to 88° F. (27° to 31·5° C.) enchances the growth and the multiplication of the plague bacillus. He further found that the bacilli thus treated retain their vitality for exceptionally long periods of time, and, above all, that their virulence actually becomes increased.

These effects were also produced, within temperatures ranging between at least 80° and 92° F., (27° to 33·5° C.), by all mixtures of air containing from 3 to 15 per cent. of carbonic acid. The effects of mixtures containing less than 3 per cent. were apparently not tested, but it may confidently be assumed that smaller percentages which are within the maxima generated in unventilated and overcrowded native houses would produce effects of the same kind. The experiments on this subject made by Captain Douglas, I.M.S., and also by Captain Spencer, R.A.M.C., but with unknown quantities of carbonic acid, have, so far as they have gone, confirmed Mr. Marsh's results. 26,233; 26,145.

The vitiation of the atmosphere which is produced when the ventilation of a chamber occupied by human beings is inadequate has apparently, therefore, the direct effect not only of stimulating the reproduction of plague bacilli, but also of enhancing the virulence of the bacilli whose number has thus been increased.

Earth and cow-dung floors increase the vitality and virulence of plague bacilli.

72. On account of the peculiar characters of the floors of the houses in which plague has most frequently occurred in India, several investigations have been made for the purpose of determining if plague micro-organisms are able to maintain a saprophytic

existence and, at the same time, retain their virulence in the substances constituting these floors.

The abundance of organic matter and moisture which the floors contain and the 20,217–8.
frequent alkalinity of their reaction, are conducive to the vitality and proliferation
of all micro-organisms, and it was therefore to be expected that investigation would 18,874.
prove, as it has done, that plague bacilli are able to live for considerable periods of time in earth and in cow-dung and in mixtures of earth and cow-dung, constituting the materials of the floors. The further facts, however, have been determined, that when cultures of plague bacilli in agar were buried nine to twelve inches deep in the floors of unoccupied native huts or in the soil of gardens, the growth of the bacilli was notably exaggerated, and after 23 and 28 days' burial, in place of presenting the usual
ground-glass appearance, the cultures had the appearance of "a thick opaque growth," 18,893.
and also that the virulence of the bacilli, even after burial for 28 days, was decidedly augmented when compared with that of bacilli grown in ordinary conditions in a laboratory. It is not improbable that these results are mainly caused, as Mr. Marsh has suggested, by the carbonic acid, which is so largely present in the ground air.

Additional evidence has thus been obtained that the conditions existing in the interior of the greatest number of native dwellings are eminently conducive to the extension and increase in virulence of plague.

Insufficiently lighted and ventilated dwellings so affect individuals as to increase their susceptibility to plague.

73. We may next consider the effect, in so far as the incidence of plague is concerned, of the insufficiency of light and ventilation upon the persons subjected to their influences. On these subjects there is no direct evidence. It would, indeed, be extremely difficult to obtain, as the conditions produced by deficient light and ventilation upon the plague bacillus are themselves so powerfully operative in enhancing the infectivity of plague, that their influence upon the susceptibility of the individual scarcely admits of being separately determined.

Effects of insufficient sunlight on persons exposed to infection.

74. This is especially the case with regard to the influence of insufficient sunlight. The necessity of sunlight for proper growth and nutrition is a physiological axiom. Its absence or deficiency is universally recognised as being detrimental to health, and conspicuously so by disordering the nutritive functions and thereby deteriorating the blood and impairing the strength. Further, the absence or deficiency would increase the air-pollution of insufficiently ventilated chambers containing organic matter. It appears, however, to be only on exceptional occasions, as in very cold or in wet weather, that native houses are occupied for long periods during the day, and as the doors and all other external openings are closed on these occasions, the detrimental influence of insufficient ventilation is introduced, and almost hopelessly complicates the problem of the determination of the effects upon individuals of the inadequacy of sunlight. Considering, further, that, in ordinary conditions and circumstances, the majority of the people of India live much out-of-doors during the day, when only any effect favourable to the extension and virulence of plague could be produced on them by the insufficient admission of sunlight into their dwellings, the influence of this insufficiency is probably exerted more upon the bacillus of plague than upon human beings. As has been shown, this influence, however, is of much importance.

Effects of deficient ventilation on persons exposed to infection.

75. On the other hand, the deleterious effect upon individuals of the conditions produced by deficient ventilation can more readily be appreciated and are of a more definite character.

Experience teaches that prolonged subjection to an impure atmosphere is one of "the most potent and widespread of all the predisposing causes of disease." It operates, not only because the impure atmosphere is defective in oxygen and rich in carbonic acid, but also because it contains volatile poisonous substances. It thus reduces the health and vitality of individuals, and it may therefore be inferred that it reduces also their resistance to hurtful influences, such as the disease-producing influence of the plague bacillus.

Wilson's "Handbook of Hygenic and Sanitary Science." 8th Edition, p. 91.

If, in accordance with general opinion, there be any susceptibility engendered by a deteriorated physical condition, it is contrary to this opinion that plague so largely infects persons in the prime of life—the highest incidence being between 15 and 30 years of age—unless it be admitted that strength and vitality are impaired by the debilitating effects of the impure atmosphere, which is especially produced and in operation in Native houses during the night. In connexion with this it is of interest to note that, in his valuable report on the Gola-rog, or Mahamari plague of Kumaun and Garhwal, Surgeon-General Planck states that "the extraordinary closeness" of the apartments in which cattle are penned at night in the same dwelling-houses as the

Evidence, Vol. II., Appendix XXV., p. 36.

Natives, "has an undoubtedly hurtful effect on the cattle . . . apparent enough to any casual observer who may see the cattle as they issue from these pens in the morning." It has already been stated (para. 3 of this Memorandum), that the basement compartment of the dwellings in which the cattle are stalled, throughout the day and night in cold weather and during the night in warm weather, is in direct atmospheric communication with the upper chamber in which the people live and sleep.

See also Chapter III., para. 350 of the Report.

Further, the facts that have been mentioned above regarding the action of carbonic acid upon the vitality, and not less upon the virulence of the plague bacillus, suggest that when in a confined and impure atmosphere, bacilli, which in a pure atmosphere would be insufficient in quantity or in virulence to produce the disease, are deposited in a skin tissue or on a mucous surface, such as that of the respiratory tract, the exalting action of the excess of carbonic acid present in the insufficiently ventilated space, aided by the elevated temperature of the insufficiently ventilated space, would so stimulate the proliferation and increase the virulence of the bacilli as to render them capable of producing a serious or fatal attack of plague.

It may also be inferred that the undue accumulation of carbonic acid in the blood and tissues, caused by the breathing of an impure atmosphere which contains it in excess, would augment the proliferation and enhance the noxious properties of any plague bacilli which may already have been introduced into the body, and would thus render the inmates of inadequately ventilated houses and rooms more susceptible than they would otherwise be to the development of plague.

Annales de l'Institut Pasteur, 25 Mai, 1899, pp. 391, 392.

These suppositions are strongly supported by the experiments of Dr. Batzaroff. Experimenting with plague bacilli, which had become so definitely attenuated by agencies hurtful to them (" milieu où il séjourne, l'oxygène de l'air, la lumière, &c."), that large quantities inoculated into the skin caused only slight and unimportant symptoms in mice and rats, and altogether failed to cause any symptoms in guinea-pigs, he found that these bacilli, when placed on the nasal mucous membrane of the latter animals, regained their virulence and produced fatal attacks of plague. When a series of guinea-pigs was thus treated, the bacilli rapidly became exalted in virulence and soon acquired an activity sufficient to kill all animals inoculated with only minute quantities. No satisfactory explanation has hitherto been advanced of these remarkable results. The bacilli, no doubt, were subjected to warmth and moisture, but these influences in other situations, such as in the skin tissues and the peritoneal cavity, have not been found to enhance the virulence of plague bacilli. An explanation may, however, be found when it is recollected that bacilli placed in the nares are during each expiration subjected to the influence of air containing so large a proportion as 5 per cent. of carbonic acid.

76. It would accordingly appear that insufficiency of sunlight and of. ventilation, aided by the peculiarities of construction which distinguish the great majority of the houses in India, are conducive to the spread of plague by stimulating both the vegetative and the pathogenic activities of the plague bacillus, and, in a less degree, by increasing the susceptibility to, or reducing the powers of resistance against, infection on the part of individuals.

VI.—Summary of preceding Evidence in support of Conclusion that Insanitary Conditions within Houses are the Chief Causes of the Extension and Virulence of Plague.

Summary of evidence that insanitary conditions within houses are the chief causes of extension and virulence of plague.

77. It has thus been shown by illustrative examples, which represent only a few of the instances contained in the Evidence and in the Reports before the Commission, that the sanitation of India is in a most backward condition, even as regards the elementary requirements of healthy existence, and that the evidence brought before us very emphatically indicates that both the extent and severity of the present epidemic of plague in that country have been largely influenced by the prevailing insanitary conditions. When this evidence is examined, it becomes apparent that a distinction is required to be made between the insanitary conditions which exist inside of dwellings and those which exist outside of them, for the great majority of the witnesses who base their opinion upon large personal experience have arrived at the conclusion that the former rather than the latter have constituted the predominating factors in the extension and virulence of the disease.

78. This conclusion has been founded upon, and supported by, many incidents in the history of the epidemic, and of the measures which have been adopted for its suppression and restriction.

It has been observed that the inmates of well lighted and ventilated houses, even when the houses are situated in the midst of plague-affected districts, have enjoyed a relative immunity from plague; while the inmates of the better class and well-built houses have suffered if the houses were insufficiently ventilated. Concentration of population has not been found to be co-relative with the incidence of plague, for the incidence may be at least as high in a sparsely populated area as in a densely populated one, provided that conditions conducive to the air vitiation of the interior of the dwellings are more powerfully in operation in the former than in the latter; while, conversely, in a densely populated area, the inmates of houses in which the air is free from gross pollution have remained unaffected, while the disease has prevailed in the surrounding air-polluted houses. The same lesson is taught by the immunity from plague which has been enjoyed by certain classes and religious communities while they live in well ventilated houses or in the open air, and even among classes—such as policemen, tramcar conductors, prostitutes, tinkers and beggars—who come much into contact with the general community in an infected place; and it has been emphasised by the disappearance of this immunity in the same classes and communities whenever, from racial habits or other causes, the protection afforded by purity of air inside the habitations did not exist. Quite as emphatic are the indications derived from the generally successful results of evacuation of infected places, and not less from the causes of failure: and from the absence of extension of plague in ships when infective material has been present; from its absence in general and plague hospitals, especially among the numerous attendant relatives and friends who, on the other hand, are rapidly and virulently affected in their own houses; and from the absence of extension in dwellings provided with the means of securing purity of the atmosphere, in which plague patients have been treated without infecting the usual inmates of the dwellings, although no special precautions against infection were taken.

It has also been observed that houses containing infective matter may be occupied without much risk during the day, when outside openings are not closed, or are closed for an insufficient period of time to produce gross pollution of the air; but that plague is propagated in them with almost unerring certainty if they are occupied during the night, when air-pollution is produced by the closing of the doors and other ventilating openings. Further, when plague-infected towns, differing mainly in the sanitary state of the interior of the houses, are compared with each other in reference to the incidence of plague, it has been seen that that incidence has been much greater where these conditions were unsatisfactory than where they were satisfactory.

79. An examination of the relationship of geological formation and of variations of climate to the incidence of plague has also supported the conclusion that the conditions existing in the interior of the great majority of native houses exercise a predominating influence upon the extension of plague; for while the former have apparently no influence, the latter have only a slight influence, and it is exerted in the interior and not the exterior of dwellings. Filth in the open air, also, appears to contribute to the spread of plague only to the extent in which it increases the air-pollution of the interior of houses, but the effect of filth within the houses operates not only in the same way as filth outside of houses, but likewise by supplying, in some forms of it, a suitable material for the vegetative life of the plague micro-organism.

Each and all of the most important circumstances relating to the history of the epidemic have, therefore, led to the conclusion that the extension of the disease, and even its great fatality, are largely dependent upon the vitiation of the air in dwellings.

80. The causes of this vitiation have been shown to be not only uncleanliness, but also the absence or the insufficiency of the means of ventilation and the overcrowding, which are both so general in native houses. While the last of these is operative by increasing the number of persons subjected to infection, it is operative to a much more important extent by adding to the air-pollution of insufficiently ventilated dwellings. Of the several elements which together constitute this air-pollution, scientific investigation has established that the increase of moisture and the elevation of temperature, so definitely produced in occupied chambers that are inadequately ventilated, are conducive to the vitality of the plague micro-organism, and has rendered it probable that the deficiency of light, and, above all, that the increase in the quantity of carbonic acid and the reduction in that of oxygen in the atmosphere of insufficiently lighted and ventilated rooms containing human beings, stimulate the

vegetative activity and enhance the virulence of any plague bacilli which may be present, and, at the same time, render the occupants more susceptible to plague than they otherwise would be.

General conclusion.

81. The conclusion, therefore, appears to be completely established that the insanitary conditions existing in the majority of native houses have exerted a direct and important influence, which is indeed a preponderating one, upon the extent and fatality of the present epidemic of plague in India.

As to other causes, they are for the most part those which contribute to the extension of all infectious diseases, with the gravely important addition of the propagation by several of the lower animals, and especially by rats; and they have elsewhere been considered. However great has been the share which has been taken by any of them, many events recorded in the Evidence clearly indicate that their influence would be much lessened, and thus the suppression and restriction of outbreaks of plague would become much less difficult than it now is, were effective measures adopted to remedy the sanitary defects so generally existing within the houses of the Natives of India.

VII.—GREAT IMPORTANCE OF IMPROVING THE SANITARY CONDITION OF DWELLINGS.

82. The accomplishment of this object is, therefore, of paramount importance. Irrespective of the reforms that have been originated by the epidemic of plague, sanitation has, 7838–40; 7810. no doubt, made substantial progress in India during the last quarter of a century, but, perhaps inevitably, to a much greater extent in the cities and large towns than in the rural districts, where, however, the greater part of the population live. In these 7841. districts, efforts have apparently been confined to "attempts in the way of cleaning tanks and improving wells, and getting away redundant vegetation"; and, occasionally, to "induce the people to resort to latrines, instead of the old plan of making every courtyard a latrine." The keeping of cattle in dwelling-houses and of heaps of manure 7922. close to houses are so universal that they do not appear to be considered defects by the sanitary officials.

83. In so far as dealing with plague is concerned, the highest authorities on the medical affairs of the country, the present Sanitary Adviser with the Government of India and his immediate predecessor, both of whom have had large experience in the present epidemic, have expressed decided views respecting the fundamental importance of sanitary reform.

After stating that inoculation, disinfection and segregation were limited in their 7988–98. applicability, Surgeon-General Harvey affirmed that improvement in sanitary conditions 7999; 7837. 26,663; 26,706. is "the essential thing" and "the one real way of dealing with plague." Surgeon-General Cleghorn, who added to the above limitations the evacuation of large cities, which, from the experience gained, appeared to be hopeless of attainment, expressed 26,711; 26,712. the opinions that "plague cannot appear and spread if the locality is in a proper sanitary condition," and that "the extinction of plague and the prevention of recurrence depend upon sanitation." These propositions are in accordance with the experience gained during all previous and contemporary epidemics of plague,* and, as it has already been shown, they are in absolute conformity with the evidence that has been submitted regarding the present epidemic in India. No propositions, indeed, that have been considered by us appear to me to have been supported by so strong and clear testimony, which also has very definitely indicated that the chief sanitary improvement required in order to prevent the extension of plague and to suppress the epidemic, is a merely elementary reform in the conditions and immediate surroundings of dwelling-houses. Until it has been made, India, it is to be feared, must continue to suffer in so far as the results of any plague measures are concerned, for all other measures will now probably remain unsuccessful, unless, not only affected villages and small towns, but also affected large towns and cities have been entirely evacuated, while the crude and destructive, but in the circumstances necessary, emergency methods adopted for introducing fresh air and light into dwellings are at the same time applied.

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* The recent epidemics in Hong Kong, Alexandria, Sydney, Oporto, Madagascar and Mauritius may be cited as examples; and in each place the highest incidence and the highest mortality were associated with the greatest degree of air-pollution within dwellings. To discuss further the import of the experience acquired from these epidemics would be neither convenient nor desirable, as the consideration of the immediate subject would thereby be greatly extended, and, more especially, as the facts relating to most of them have not been fully collected and are, therefore, only imperfectly known.

84. This consideration becomes all the more important as it is unfortunately apparent that the effective evacuation of cities and large towns cannot be accomplished, and that they will, therefore, continue to be centres of infection from which plague will be imported into previously unaffected places, as well as into places which, at great expense and after many hardships, have freed themselves from outbreaks by carrying out evacuation with disinfection by air and sunlight.

26,664; 26,683-5

Further, if in the absence of this sanitary requirement, measures, other than those proved by experience to be the only effective ones, are employed during the first outbreak of plague in a place, a false and dangerous trust may readily be engendered in altogether ineffective action, by the fact being overlooked that the first outbreak is not infrequently a mild one, irrespective of the action that is taken, as has been exemplified, for instance, in Calcutta, Mysore City, Baroda and Poona. (*See* Report, paras. 36, 37, 38; and Appendix II. *ante*, footnote, p. 437.)

Sanitary improvement of dwellings would render the suppression of the epidemic possible by practicable and relatively simple measures.

85. On the other hand, if the elementary requirements of pure air and light in dwelling-houses were provided, it is probable that the existing epidemic could be suppressed, and the possibility of recurrences of similarly wide-spread and virulent epidemics would be greatly lessened, if not altogether removed.

Weekly Statement of Plague cases and deaths, issued by the Government of Bombay.

In addition to the many incidents that have already been cited in support of these statements, the conspicuous relative immunity of the Europeans in India may again be referred to. In the Bombay Presidency, from September 1896 to 1st June 1900, the total number, exclusive of Europeans, of the discovered cases of plague was 392,385, and of plague deaths 308,140, giving a case-mortality of 78·5 per cent. In the same period, the number of cases among Europeans was 202, and of deaths 59, giving a case-mortality of 29·2 per cent. Further, the Europeans may be divided into those who lived in Bombay and those who lived in other parts of the Presidency (Mofussil), including the small towns, cantonments and rural districts. In the former division, there were many Europeans who resided in houses in the streets of Bombay, in the midst or in the immediate neighbourhood of the insanitary conditions existing in the native quarters; while in the latter division, all but a small number lived in the Cantonments or the Civil Lines, or outside of the native quarters, and for the most part in isolated villa-like bungalows. In the former group, the case-mortality from plague was 33·9 per cent., while in the latter group it was only 22·6 per cent. Where, therefore, the dwellings in which plague has occurred are grossly defective in their supply of pure air and light, the case-mortality is the greatest; where these important factors in limiting the virulence of the disease are not grossly defective, the mortality is the least; and, further, when among the latter, a number of the dwellings are less perfectly supplied than others with these and other sanitary requisites, the plague mortality is greater than in the dwellings where they are more perfectly supplied.

To the same effect was the experience gained in Bangalore of the mortality from plague in three groups of patients, whose relationship to fresh air and sunlight likewise varied definitely. One of these groups consisted of plague contacts, who, on becoming affected in the well ventilated segregation camp, were removed to the plague hospitals; the second group consisted of plague patients who became affected in the city, and were thereupon removed to the hospitals; and the third group of plague patients who also became affected in the city, but were treated in their own houses, and not in the plague hospitals. In the first group, the case-mortality was 53·69 per cent.; in the second group, it was 68·77 per cent; and in the third group, 97·06 per cent.

Madhava Rao's Report, p. 9.

The relationship between air-pollution and the virulence of plague is also illustrated by the following incident. While plague of an extremely virulent type was present in Worli, so that of the persons attacked 96 per cent died, 250 of the inhabitants went by road to the Karli Caves at Lanauli, some 60 miles distant from Worli, and while residing there several cases occurred, but they were of so mild a character that none of them proved fatal. The great deficiency of ventilation and of light in the affected houses of this village has already been described (paragraph 7). The virulent infective matter carried from these houses was subjected to the influence of fresh air and of light, both during the journey by road and in the open caves at Karli, and apparently it was thereby so mitigated that, although it still retained sufficient activity to produce the disease, it was no longer capable of causing death.

Gatacre's Report, pp. 188-9.

Sir Andrew Wingate, whose knowledge of the circumstances attending the extension of the epidemic in India is probably unequalled, has observed, in a statement more fully quoted in Chapter III., paragraph 378, of our Report, that "the outflow from an infected area is probably more dangerous close to the centre of infection than at any

26,537

distance from it; that as the outflow gets further away from the centre, so the danger seems to lessen," notwithstanding the circumstance that communication with the more distant place may be greater in amount than with the less distant,—a character of the spread of plague which clearly harmonises with the supposition that exposure to air and sunlight reduces the infectivity and virulence of the disease.

Satisfactory sanitary conditions greatly lessen the difficulties of prevention and suppression.

11,379-80; 22,703; 22,720. 23,923-8; 23,943; 23,916.

86. As, however, plague is an infectious disease, produced by a specific micro-organism, it is not to be expected that its occurrence could be altogether prevented by the removal of air-pollution and other fostering agencies from dwelling-houses. At the same time, were these fundamental and predominating causes of the active extension and enhanced virulence of plague removed, the other measures necessary for its suppression would become so reduced in number, and would be rendered so much easier of application, that the suppression of a wide-spread epidemic, involving cities of large size, would no longer remain an almost hopeless task. The complete evacuation of cities and villages, for example, would not then be required, the disinfection of all houses in affected places would be unnecessary, and the crude and temporary method of effecting ventilation by unroofing houses and breaking holes in their walls, would become superfluous. In so far as repressive measures are concerned, the conditions would be much the same as in a European bungalow, or in a plague hospital, or in the properly constructed huts of an evacuation camp; in none of which are harassing and expensive measures considered necessary, and still plague so rarely extends in them that it becomes an easily controlled infectious disease, and loses the formidable characteristics which distinguish it in a native town or village. In the sufficiently lighted and ventilated Native house, the suppression of plague would be as easily accomplished as in the bungalow of the European, and would require little more than the isolation of the patient and the adoption of such relatively simple measures for the prevention of extension by persons and things as, in Great Britain and elsewhere, are successfully employed in scarlet fever, or small-pox or typhus fever.*

Satisfactory sanitary conditions greatly reduce the danger of spread by rats.

87. Even the very special and, in Indian towns and villages, at present insuperable difficulty of preventing the spread of infection by rats would be greatly lessened, for these animals shun well-lighted and airy quarters, in which, further, the infective power and virulence of the plague bacillus is much reduced, and may, indeed, be so greatly reduced that this medium of communicating the disease would entirely be deprived of its formidable potency. As the providing of reasonably pure air also requires that polluting accummulations should not be present within dwellings or in their neighbourhood, the means for securing this provision would further lessen the propagation of plague by rats, by the requirement of properly laid and trapped sewers in municipal towns, and, both in the larger towns and in villages, by the removal of pit privies and "filth of man and beast" from the interior or vicinity of houses, and by the prevention of the keeping of cattle, with accumulations of manure and fodder, in the interior of dwellings, or in close proximity to them. When by these several sanitary reforms, obviously required irrespective of plague, and by the judicious regulation of the storage of grain, the vast numbers of rats which now infest the houses of many native towns and villages have become reduced, a reasonable opportunity will be given for success in the employment of disinfection by chemical substances, the signal failure of which as a plague measure, even when carried out with every care by trained operators using trustworthy disinfectants under skilled supervision, has hitherto proved one of the most disappointing incidents in the history of the present epidemic. These considerations acquire an additional importance from

22,649.

Snow's Report, pp. 70, 82-95; James' Report, pp. 97, 98; 23,196; 23,317; 20,158; 20,184-90; 20,197-202; 22,062; 22,137; 24,450-5;

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* The relative simplicity of the measures that are adequate, as well as the relative mildness of plague where gross air-pollution of dwellings is not present, have been fully illustrated in the recent outbreak in Glasgow (1900), a city comparable with Bombay in the number of its inhabitants, and having the highest ratio in Scotland of population per acre. Indigenous plague cases had occurred in two widely separated parts of that city at least a fortnight before the existence of the disease had been discovered by the Sanitary Authority. Every known case was thereafter removed to hospital, the contacts were segregated but allowed to follow their occupations during the day in any part of the city, and the infected houses and their contents were disinfected with chemical substances and with free exposure to the air.

The outbreak was suppressed in about twenty-four days; and in that time the total number of definitely diagnosed and of probable or suspicious cases was 36, but only 16 of them proved fatal, representing a case-mortality of 44 per cent. Eight of these fatal cases, however, were merely suspected cases, which were not diagnosed during life, and, therefore, they cannot properly be taken into account in estimating the case-mortality; for if it be assumed that they were cases of plague, an unknown number of non-fatal and undiscovered cases must also be assumed to have occurred. If only the undoubted cases are considered, the case-mortality was so low as 28·5 per cent., and, therefore, was much the same as that of the Europeans who became infected with plague in the Bombay Presidency.

the circumstance that even if there were a reasonable prospect of success in materially reducing the number of rats by poison, or capture, or the employment of microbean agents of destruction, grave difficulties in applying these measures would be caused in India by religious beliefs and caste prejudices. 19,455–64; 9175; our Report, App. V., paragraphs 5, 6, 10.

88. The position may briefly be summarised as follows:— **Summary.**

Plague is an infectious disease fostered chiefly (*a*) by insanitary conditions, the most important of which is air-pollution within dwellings, and (*b*) by rats.

If both *a* and *b* be present, the suppression of a wide-spread epidemic is practically impossible, unless complete evacuation of every infected place be carried out.

If there be no considerable number of rats, the suppression is less difficult than it otherwise would be.

If there be no gross air-pollution within dwellings, the suppression is not attended with any special difficulty, for, in that case, the chief agency in enhancing infectivity and virulence would be absent, and rat-infection would cease to be an important factor in the extension of the disease.

VIII.—MINIMAL SANITARY REQUIREMENTS FOR DWELLINGS.

89. It would thus appear that, in order to render it possible to suppress in India an existing wide-spread epidemic of plague,* involving cities and towns of so large size that their complete evacuation cannot be effected, and also in order to prevent in the future the occurrence in that country of extensive epidemics of plague, it is necessary that—

1. Each room in a dwelling-house should be provided with a window for the admission of air and daylight; and that—
2. Each house, and its immediate surroundings, should be kept reasonably free from all causes of air-pollution.

The measures required for securing the latter condition are self-evident, but on account of the special conditions encountered in India, it may not be unnecessary to state that cattle should not be stalled in dwelling-houses, and that it is advisable that stone, cement, tiles, or wood should be used in place of earth in the construction of floors, and that cow-dung should not be applied to the floors or interior walls of houses.

90. The prevention of the overcrowding which is so common in Native houses, is naturally suggested as a requirement that should be included among the above. As, however, the main object of this prevention would be the securing of an atmosphere of sufficient purity for healthy existence, it is obvious that this could not, at present, be attained by any limitation in the number of the occupants of a chamber based on its cubic capacity; for in the great majority of the towns and villages, the houses of Natives are either unprovided with sufficient means of ventilation, or are provided with external openings which could only admit air already much polluted by external filth. It is almost superfluous to add that as soon as provision has been made for the admission of pure or even fairly pure air into dwellings, the prevention of overcrowding would become an effective and necessary measure for maintaining an unpolluted atmosphere. **Until means for sufficient ventilation and lighting provided, reduction of "overcrowding" of little use.**

91. When contrasted with several other infectious diseases, plague, therefore, requires for its extinction and prevention relatively simple, inexpensive and always obtainable conditions. Cholera, for example, has been greatly lessened wherever a pure water supply has been provided. This, however, has only been accomplished by sinking new wells and constructing carefully protected tanks to take the place of polluted wells and pools, and by carrying out large schemes of water collection, storage and distribution, which constitute some of the most gratifying results of enlightened enterprise in the government of India; but even when all this has been done, drought and famine may render nugatory the provision that has been made. There are, besides, vast districts and many towns and villages in India where a pure supply of water is either altogether unattainable or attainable at so large an expense as to be beyond the resources of the country. On the other hand, pure air, the chief requirement for the extinction and prevention of plague, is everywhere obtainable, and may everywhere be introduced into dwellings by relatively simple and inexpensive measures. **Minimal requirements not great and always obtainable.** 8061.

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* The measures which appear to me to be necessary for extinguishing a local outbreak in its early stage, even when it has occurred in a large town, have been described in Appendix V., paragraph 11, of our Report.

Where any considerable expenditure of money is required, it is not for the purpose of admitting the always available pure air, but for that of preventing its pollution by such gross neglect of sanitary requirements as not only favours the propagation of plague, but continuously, year after year, acts deleteriously upon the public health, and largely increases the death-rate of the country.

Difficulties in effecting the minimal sanitary improvements.

92. Although the sanitary requirements, which have been shown to be essential before the epidemic of plague can be suppressed, appear to be of an elementary character, the history of sanitation in India renders it probable that much difficulty may be encountered, and that a strong effort may be necessary before they are carried into effect. The gain, however, would be so great, for it implies no less than the removal of an otherwise hopeless position in so far as human agency is concerned, that it is important to consider what constitute the chief difficulties, and to what extent and by what means they may be surmounted.

Much sanitary reform effected since the epidemic began.
7868.
968; Gatacre's Report, p. 185.
Snow's Report, pp. 4, 82, 87, 92, 100.
24,191.
24,459; 15,929–30.
13,505–6.
8843.
Inglis' Report, p. 143.
8096–7.
15,156.
25,700–2; 22,654.

93. To assist in the consideration of these subjects, it would be useful to recall what has been done in the direction of sanitary improvement during the existence of the epidemic. As the progress of the epidemic throughout the country, as well as the development of local outbreaks, has been slow, while, especially in cities and large towns, outbreaks have so frequently recurred, that it may be anticipated that any place which has once been affected will again suffer from the disease, ample opportunities have been afforded for activity in sanitary work. In many places, these opportunities have been taken advantage of both with the object of reducing the chances of threatened outbreaks, and with that of aiding in the suppression of already existing outbreaks. In Bombay City, 5,000 coolies, in addition to the permanent establishment, were at one time employed, day and night, in flushing the drains with expensive disinfectants, in removing the tiles of houses, and in limewashing the exterior and interior of buildings with an expenditure of hundreds of tons of quicklime; the outside of houses, and the gullies, lanes and streets were flooded with disinfectant solutions by means of fire-engines and other steam and hand pumps; in September and November 1896, 1,337 men were employed in removing silt from drains, which were then thoroughly flushed with millions of gallons of sea-water and carbolic acid, and provided with 450 manholes, and, at a later time, 200 men were employed in opening up drains and removing deposited matter from them; the "down-pipes" of numerous houses were removed in order that they might be cleaned, by washing with boiling water, scraping the interior, and steeping in phenyle baths; and between September 1896 and March 1897, houses to the number of 10,748, in at least half of which plague cases had occurred, were thoroughly flushed with disinfectants, cleansed, and limewashed. Ahmednagar was twice completely cleaned and disinfected, and in the Cantonment, all the private latrines were disinfected and destroyed; in Surat, several thousand pit privies were filled in and open privies constructed in their place, and a large establishment was engaged to clean the town; many uninhabitable houses were demolished in Mandvi, the latrines were removed outside of the boundaries of the town, and, with the aid of a large staff of additional sweepers, the town was at length made fairly clean; in anticipation of plague, great activity was manifested in the larger cities of the North West Provinces, in improving latrines and closing dirty wells, and in 96 villages of the Balachour Division the "people were persuaded to cleanse their houses;" Quetta and all the important district out-stations were thoroughly cleaned, and houses found unfit for human habitation were pulled down, but the ordinary villages were not dealt with; two or three of the towns in Baroda State were put in good sanitary condition by widening streets, improving the water supply, and organising a system of house conservancy; and the ventilation of several of the houses in Bombay, Karachi, Baroda, and a few of the other larger towns, was improved by permanent structural changes.

In many other places, sanitary operations, restricted for the most part to the removal of filth, have been carried out in a large, and even a gigantic scale, but the above examples are sufficient to illustrate the sanitary activity which has been stimulated by the epidemic, and to demonstrate that, when in India it is earnestly desired to effect sanitary improvements, the difficulties that exist are by no means insuperable.

The mere removal of filth shown to be inadequate as a plague measure.

94. It would be premature to expect any definite results from these emergency measures upon the public health, and, probably, also unreasonable to do so, in view of the enormous residue of insanitation which has been left untouched, even in

the places where the measures were carried out. Their object, however, was to curtail the extension of plague; and while it is impossible to assert that no impression was produced, the evidence clearly shows that they have failed to appreciably affect either the extension or the virulence of the disease. This conclusion, which unfortunately, has been fully established by the growth of the epidemic, and the records of the mortality during four years of sanitary activity, as well as by the recurrence of successive outbreaks, frequently of increasing severity, in the large towns and cities, has been expressed in the following words in General Gatacre's Report: "Where the surroundings are hopelessly insanitary, and where buildings are overcrowded, . . . and the rooms contain no means of ventilation except the door, sanitary operations" (by which are implied such cleansing and filth-removal operations as have been described above) "have little or no effect in stopping the disease."

p. 186.

95. For reasons which have already been stated, it is not to be overlooked, however, that as the predominating factors in the diffusion and the increase in virulence of plague are the polluted atmosphere and other conditions existent in the interior of inadequately ventilated and lighted dwellings, the measures for the removal of this pollution must include such sanitary improvements outside of dwellings as have almost alone received attention during plague operations; although they themselves, however complete and thorough, cannot be successful so long as pure air and light are not admitted into the interior of the dwellings. That efforts have not been more generally made to secure these requisites cannot be explained by the absence of appreciation of their great influence upon the diffusion and virulence of plague, for, as we have seen, this has very largely been recognised by both Europeans and Natives, and, indeed, it could scarcely fail to be made manifest by the everyday incidents of the epidemic, such as the immunity in hospitals and evacuation camps. It is possible that their predominating importance has, to a large extent, been overlooked in the presence of the more obtrusive sanitary evils prevailing outside of houses, but the explanation of the absence of any general effort to include the permanent ventilation of dwelling-houses among the sanitary improvements which have so largely been carried out, may likewise be found in the expectations that the financial difficulties are too great to be overcome, and that the people would themselves so uncompromisingly oppose this reform as to render its introduction inadvisable or impracticable.

Financial difficulties.

96. With regard to the financial difficulty, no doubt expenditure would be required before each room of a dwelling-house could be provided with adequate external openings for the admission of air and light. In so far as this difficulty affects places which are suffering or have recently suffered from outbreaks of plague, it is probable that little additional expense would be incurred in rendering permanent the temporary openings for ventilation, which, when combined with the evacuation of the houses, constitute the most frequently and successfully adopted of plague measures, instead of closing the openings when the houses are re-occupied, and, in many places, repeating this process of breaking holes in walls and repairing the destruction thus caused on the recurrence of successive outbreaks.

In places threatened with plague, the expense of providing permanent means for admitting sufficient air and light into houses would add but little to the pecuniary expenditure incurred in the removal of accumulations of filth, the clearing of drains, and the cleansing of streets and houses, with a lavish distribution of disinfectants, which are the sanitary measures that have most frequently been trusted to in the defence against plague. If, however, the houses were already provided with permanent openings for ventilation and were sufficiently supplied with pure air and light, plague when imported into the place would fail to produce so extensive and virulent an outbreak as would otherwise occur, while the breaking of walls and roofs and other plague measures would be unnecessary; and thus not only would the outbreak become controllable, even in a large town, but the expenses incurred in suppressing it would be much reduced.

Further, as the adequate provision of unpolluted air and of light in dwellings is necessary before the epidemic can be stamped out, and is an essential condition in the defence against outbreaks of plague, the consideration naturally arises that expenditure for all other measures—and both in individual places and collectively it has already been great—must be futile and unavailing so long as that which is necessary and essential is not also provided.

Nathan's "Plague in India," Vol. I., pp. 193-7; Madhava Rao's Report, p. xlix; 26,664.

Both in plague-affected and in plague-threatened places, the existence of imminent danger would greatly lessen the pecuniary and other difficulties which might otherwise present themselves. That it is by no means hopeless to secure the acquiescence, if not co-operation of the people, has been shown by the experience gained at Baroda, where windows have been introduced into houses which were previously unventilated, without much expense and with almost no opposition, by the exercise of "a little persuasion and a little firmness." 15,157, 15,160–1

Opposition of the people.

Address to Members of the First Indian Medical Congress by Surg.-Colonel Harvey, 1895, p. 44.

97. As to the anticipated opposition from "the ignorance, prejudices, callousness and superstitions of the people," it may, in the first place, be noted that in all countries sanitary reform has had to contend with these causes of obstruction, but that wherever a policy of reform has been seriously and earnestly adopted, the obstruction has been unable to prevent its progress. The stimulus of the plague epidemic has already done much to advance sanitary education in India and to break down the barriers raised by the apathy and prejudices of the people. While the first introduction of plague measures caused much disfavour and excitement, and in a few places even active hostility, as the objects of these measures and the evidence of the benefits produced by them became manifest, the opposition has largely, and in some districts, entirely disappeared. In nearly every plague-affected place, evacuation, on its first adoption, encountered much opposition, but the inhabitants soon learned to appreciate its advantages. In many places, indeed, they have shown an inconvenient preference for the open and sunny huts of the evacuation camp over their ill-ventilated and lighted houses, and the prediction of Surgeon-General Planck has over and over again been verified that "when plague becomes well-known on the Plains of India, the people will flee out of their houses of their own accord." To mention only another and an extreme example, no plague measure has excited more determined resistance, arising from family relationships, caste prejudices, and grotesquely childish misconceptions, than the isolation and treatment of patients in hospitals; and, nevertheless, by tact and by the natural diffusion of knowledge gained by experience, this opposition has already subsided in several places, and patients are with their own consent brought voluntarily by friends and relatives for isolation and treatment in plague hospitals.

14,758–63; 15,115–6; 15,168; 15,865–7; 23,996–24,001; 24,058–9. 26,656; 26,668. Burnett's Report, pp. 3, 5; 9; 11,375; 14,635. 26,575.

Campbell's Report, p. 112; Gatacre's Report, p. 133; 1863–7; 7863, 11,246; 26,550.

Structural sanitary improvements effected without opposition.

98. During the activity in sanitary reform, originated by the epidemic, few attempts were made, excepting in some of the larger cities, to effect permanent structural improvements by which air and light could be introduced into dwelling-houses, and, therefore, little experience is available for judging of the attitude of the people towards this reform. In the few places where it was carried out, however, the experience that was gained is not unfavourable for the future success of this pre-eminently valuable plague measure. 24,347. While the systematic opening up of houses was being effected in the city of Ahmednagar, many of them were found to be so destitute of means for ventilation that "air and light had never got into them since they were constructed." The owners were required by the Municipality to provide windows and other ventilating openings, and although many of the poorer and more ignorant of the inhabitants obstructed the windows with curtains and purdahs, the better class of the inhabitants made proper use of them, and it was believed by the Chairman of the Plague Committee, that even the poorer class would "gradually come to appreciate the value of light and ventilation." 24,362. This opinion was endorsed by the Cantonment Magistrate, Captain Walton, I.S.C., who had, apparently on a larger scale, effected similar reforms in the houses of the Cantonment, 24,203–9. and had required that condemned houses should be rebuilt "on a particular pattern," with "two windows in each room and a ventilator in the roof," so as to secure "lots of ventilation, big doors, and a good height to the roofs." 24,191; 24,203. In Baroda State, houses without means of ventilation were provided with windows in each room, so as to allow "plenty of light and air to get in," 15,157. and this, as well as the other sanitary improvements which were made, was stated by the district magistrate to be much liked by all the people except the Machis, who feared that their property would not be secure if the walls of the houses had openings, their custom being to "turn their houses into a regular box." 15,163–5. In drawing attention to the freedom from plague, during 1898–9, in certain wards in Satara, which had been infected during the previous year, Captain Thompson, I.M.S., stated that the inhabitants of these wards, induced by example and by the persuasion of their leaders, were "following those supreme safeguards, and running the risk of dying of diseases which they thought were caused by cold air rather than die of plague," and that native doctors had told him "that many in the city are following these safeguards with regard to ventilation and cleanliness of their houses." 22,432–4. The experience gained in the Mysore State is, however, even more definite and encouraging. Among the plague measures in Bangalore City, was the sanitary improvement of a large number of houses, which had been temporarily vacated because of an outbreak of plague, by

providing them with permanent openings for admitting air and light. The Plague Commissioner of the State informed us that the people were already beginning to 3268; 3271. appreciate the advantages of ventilation and of the improved lighting of their houses, and he anticipated that they would themselves voluntarily make the structural alterations required for obtaining these advantages. Subsequently to his examination, he has supplied the information that a large number of houses in other parts of the State have been provided with windows, that no cases have come to his knowledge in which windows made by the Authorities have been closed, and that all the chief plague and medical officials whom he had consulted had also met with no instances in which that had been done. In the villages as well as in the towns, the advantages of the free ventilation obtained by the openings made to admit air and light into dwellings were being appreciated, and there had been many instances of people themselves making such openings. In further confirmation of the opinion that sanitary improvements, which include ample provision for securing pure air and light in dwelling-houses, are not rendered impracticable by the opposition of the people, it may be added that improvements on a large scale have been initiated in Bangalore City, which involve the demolition of 2,600 houses in order that over-populated districts might be opened out, and involve also the formation of two large extension areas of nearly a thousand acres, for the accommodation of 50,000 people, in houses 3261; 3481. liberally supplied with means for admitting light and air, and provided on every side with well-drained open spaces.

Causes of general existence of unventilated houses.

99. It is frequently stated that the great majority of the Native houses are unprovided with sufficient openings for the admission of air and sunlight because ventilation and light are obnoxious to the habits and prejudices of the people and are otherwise distasteful to them. This, however, is not the explanation which is advanced by several of the most intelligent of the natives themselves. Mr. Madhava Rao, C.I.E., for example, considers that the cause is not to be found in family or caste requirements or the anticipation of discomfort, but in the survival, from a bygone period of misrule and insecurity, of now unnecessary precautions against robbery and violence. This explanation has also been advanced by European Medical Officials who have had long experience of native customs and prejudices.

100. It has also been stated that even if the houses of Natives were provided with windows, a deeply rooted disinclination to admit air and daylight would lead the inhabitants to close the windows. It does not appear justifiable to assume that this would generally be persisted in, in view of the circumstance that the great majority of the Natives of India live in houses either altogether or very insufficiently provided with special means for admitting air and sunlight, and as yet, therefore, have had no opportunity of experiencing and enjoying the benefits of pure air and daylight in their dwellings.

101. It is not improbable that the chief cause of the prevailing absence of windows or other special permanent openings for the admission of air and light into houses is that suggested by a witness as applicable to the general neglect of sanitation in native towns and villages, previously to the occurrence of the present epidemic of plague, "the people did not understand its importance before, and no one took any interest in 15,155. it."

IX.—How the necessary Sanitary Reforms may be carried out.

102. The importance of this reform can, however, no longer be overlooked, for there appears to be little hope of suppressing the epidemic until it has been effected. The manner of accomplishing it may, therefore, now be considered, and for this purpose it would be convenient to draw a distinction between (*a*) places which are or have been infected or are in such proximity or relationship to them as to be in immediate danger of becoming infected, and (*b*) places which are so remote from infected localities that the danger of outbreaks in them has not been sufficiently realised to originate precautionary measures.

In places already affected or threatened with plague.

103. In the former group, municipal and emergency organisations are already in operation which would be able to include in their sanitary work the providing of permanent means of ventilating all houses which could with propriety continue to be occupied, while of the number which do not fall within this category, these organisations would be sufficient to ensure that the new houses which are constructed in

substitution should have a window in each room. The reform would be much 26,803. facilitated by the extension and improvement schemes in operation or under consideration in Bombay, Calcutta and other cities and towns, where many of the existing houses have been so constructed and are so situated that windows opening into the Snow's Report, p. 185, para. 684, p. 187, para. 692. external air either cannot be provided, or, when provided, would fail to supply the interior of the house with a sufficiency of air and sunlight, even although pollution of the air near the dwellings were prevented by efficient drainage and conservancy.

In places remote from centres of infection.

104. The second group includes places which are either unprovided with a sufficient organisation, or are provided with one that has not yet taken action under the panic of impending danger, nor under the influence of a reasonable desire to adopt measures for averting or lessening a possible calamity.

The importance of effecting at least the essential sanitary reforms in these places is apparent when it is realised that no place, however remote from centres of infection, can be regarded as protected by its position. It is no doubt the case that both in India and other countries, former epidemics of plague have occasionally been limited to restricted areas, and, from causes which are not in all cases apparent,* have finally disappeared, after an existence of only a few years. Any expectation that the first event may be realised in India has, however, already been dispelled. Any hope that the epidemic will have only a short duration cannot be entertained irrespective of the considerations that this has been rendered improbable by the recent great increase in the facilities for inter-communication, and the large extent to which they are being used, and by the great difficulty, if not the impossibility, of totally evacuating every plague-infected place and freely opening up the vacated houses; without which, in the prevailing insanitary conditions and especially the insanitary conditions within dwelling-houses, plague cannot be suppressed in the great centres of infection. Further, if there be any agency, in addition to effective plague measures, which can cause an epidemic to cease, that agency is entirely unknown and therefore it is neither available for intentional application nor can its interposition confidently or even reasonably be trusted to.†

It is possible that in the places included in this group, inaction may be stimulated by persuasion, or by the diffusion of information, or by obtaining the co-operation of the leaders of the people; for the Native of India appears, for the most part, to be 26,802 easily led by precept and example. If these methods fail, official pressure would no doubt prove successful, and the amount of it will necessarily rest with the governing authorities, who can best appreciate the issues that are involved. In doing so, consideration should primarily be given to the circumstance that there is little prospect of the epidemic being suppressed until the large cities and towns have been freed from plague.

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X.—A New Sanitary Organisation required for India.

105. All these methods, however, must be regarded as temporary expedients by which the present emergency may be met. While they would provide the means for obtaining a satisfactory condition of sanitation within dwelling-houses, they are inadequate to ensure that this condition would be maintained, and they are also insufficient to provide for the continuance and expansion of the sanitary reforms that may be effected and are urgently required.

106. From the information that has been placed before us it is impossible to arrive at any other conclusion than that the existing sanitary organisation would be unable to 26,793. realise these objects. It is, indeed, generally admitted to be an organisation which, notwithstanding the zeal and accomplishments of its members, is inadequate for the needs of India even when the aims are restricted within very moderate limits, with such results, however, as have been illustrated in the earlier portions of this Memorandum. We have therefore recommended, in broad outline, a scheme for a new organisation, leaving numerous details for adjustment and future development. (*See* Chapter VII., II., of our Report.)

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* Several causes which may probably explain the cessation of former plague epidemics, when no measures likely to produce this result were applied, are not here referred to, such as the accidental destruction of the whole or large portions of affected cities, or the lessening of the insanitary conditions within dwelling-houses by a large reduction of the population, produced by panic or by heavy mortality from the disease.

† In this category may be placed the slowly produced extinction of an epidemic possibly caused by a gradual attenuation of the plague bacillus, or by a considerable proportion of the population having acquired immunity on recovering from slight attacks of the disease, or by a combination of both circumstances.

Scheme proposed by Commission. 26,638 (last para.).

107. The fundamental proposals in that scheme are an increase in the number of officials specially qualified in Public Health, and the formation of a separate Sanitary Service controlled by one medical director,* attached to the Supreme Government, who shall be required to devote his whole time to sanitation, and shall be provided with an adequate staff, in which, I would venture to suggest, an expert in sanitary engineering should be included.

108. Further details would be matters of administrative convenience and efficiency, such as (*a*) whether there should also be in each Presidency and Province, a chief officer acting under the medical director, in which event a Presidency or Provincial staff would also be required; but, in any case, Local Governments as well as Urban and Rural Authorities should be entitled to initiate and carry out any sanitary improvements, subject to the supervision and approval of Government; (*b*) whether the distribution of the chief sanitary officials should be made in consultation with provincial governments and municipal and district Authorities; and (*c*) whether such Municipalities or other Sanitary Authorities as contribute to the payment of Medical Officers of Health should be entitled to appoint, although not to dismiss, their officers, subject to approval by the sanitary director of their qualifications and satisfactory performance of duty.

109. Our recommendations also include proposals which, if adopted, will, it is to be hoped, afterwards give place to more satisfactory permanent arangements. In view of the engrossing and multifarious nature of their other duties, it does not appear possible for Civil Surgeons even to inform themselves of the sanitary requirements of their extensive districts, much less to supervise or direct sanitary affairs in them; and, therefore, the recommendation we have made regarding these officials should, I think, be regarded as only a temporary expedient, to be afterwards superseded by the appointment of Health Officers whose time would be entirely devoted to sanitary work. 7730, 7813-4; 7912; 10,503-12.

110. Further, several obvious requirements have not been included in our recommendations, one of the most important of them being the appointment of intelligent and trustworthy subordinate inspectors, trained in the elements of sanitation, qualified to disinfect houses and things, and able, in their daily intercourse with Natives, to give advice and encouragement in rudimentary sanitary precautions.† 3920-3; 3956.

111. The local officials, both urban and rural, would thus constitute an organisation for removing the prevailing ignorance regarding the beneficial aims and results of sanitation, and for obtaining the co-operation of the people in the adoption of sanitary reforms, which are not only at present urgently required for the suppression of plague, but, on account of the rapid increase of population and of inter-communication between all parts of India, are daily becoming even more necessary than they formerly were for the prevention of the excessive mortality from preventible diseases.

112. While hasty and inconsiderate action is to be deprecated and much patience and tact exercised in the education of public opinion, it does not appear that the conditions even now existing, are everywhere unfavourable to effective sanitary work. Many instances have already been adduced of successful operations in towns and villages, and the Sanitary Commissioner of the North West Provinces has described a systematic series of operations—including the visitation of nearly every house in the cities and towns of those Provinces by specially appointed Health Officers and by Civil Surgeons, and the removal from them and their surroundings of the observed insanitary conditions—which were carried out in anticipation of plague, apparently without causing irritation, and which are actually some of the most important of the duties that would devolve upon the officials of a properly constructed Sanitary Service. It was stated, also, that the required sanitary improvements were made by the owners of the houses, except in the cases in which the owners were poor, when assistance was given by the Municipalities. If these and similar operations are carried out with tact and discretion, there is some difficulty in understanding how, as one witness informed us, popular discontent, sufficient to raise a political issue, would be produced by the endeavour to prevent the keeping of cattle in dwelling-houses, or the accumulating of manure close to houses, or the washing of clothes or voiding of urine in the same part of a stream from which drinking water is drawn. 8843; 8973-8. 7922-5.

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* The word "director" is used merely for convenience, and not with any intention of suggesting a designation for the Head of the Service.

† The progress of sanitation would also be much benefited by the introduction of a system of registration of all medical men holding qualifications from institutions recognised for the purpose by Government, for thereby the foundation would be laid of a much required accuracy in Death Returns. 26,734; 26,760-9. 8054; 8855-9.

8069. 113. The explanation can only be found in the absence of information regarding the dangers that are incurred, and the injury to health that results from these and similar practices; for many incidents during the epidemic have shown that the Native of India, although capable of bearing hardships with much patience and fortitude, does not generally exhibit any inhuman disregard for personal safety in the presence of realised and avoidable danger. The diffusion of information regarding even the mere elements of sanitation thus acquires much importance, and to further this object, it is
3982. desirable that special attention should be given to the training in Hygiene of the native practitioners, so that intelligent interest may be taken in sanitation, and the knowledge of its requirements extended through their instrumentality and that of the members of the Sanitary Service to the inhabitants of villages as well as of towns.

114. If by the several means that have been indicated the activity in sanitary reform, which has been created by the present epidemic of plague, should be maintained and developed, India will ultimately be more than recompensed for the great sacrifice of life and the hardships and pecuniary losses which are being caused by the pestilence.

T. R. F.

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APPENDIX IV.

MEASURES FOR THE DISCOVERY OF PLAGUE DEATHS.

MEMORANDUM OF DISSENT BY DR. WRIGHT AND DR. RUFFER.

Dissent not on matters of detail, but on matters involving grave practical issues.

1. In placing on record our dissent from the views expressed by our colleagues on the subject of the measures for the discovery of plague after death, we desire at the very outset to make it plain that the differences between our views and those which are held by our colleagues are differences, not on matters of detail, but on matters involving very grave practical issues.

The gravity of the issues which are involved in a decision to rely upon this or that measure for the discovery of plague will be manifest when it is considered that the effectiveness of a particular measure, whether it be one of disinfection or of isolation, will depend primarily upon the adequacy of the information which is placed at the disposal of the person entrusted with the carrying out of that particular measure.

Measures for discovery of plague cases during life ineffectual, except in small places and exceptional circumstances.

2. We need not here pass again in review the measures which have been employed with a view to securing the discovery of plague cases during life, for the evidence which has been laid before us has convinced us, as it has convinced our colleagues, that it is impracticable, unless in small places and under exceptional circumstances, to adopt any measures which will effectively secure the discovery during life of all, or anything like all, the plague cases.

Abandonment of compulsory isolation of sick agreed to in expectation that this will render less difficult the obtaining of full information of all plague deaths. Para. 610 of this Report.

3. Failing the means of coming by such information, we are persuaded that no measures for the isolation of the sick can ever be effective unless where plague is confined to very small limits. We desire, however, to make it plain that in participating in the recommendation that the attempt compulsorily to remove all plague cases to hospital should be abandoned, unless under circumstances favourable to the effectual carrying out of this measure, we have looked beyond the fact that difficulties are experienced in carrying out this measure, and also beyond the fact that the hardship which is inflicted by it on individuals is disproportionate to the benefit achieved by it. We have looked in particular to the probability that, in cases where measures for isolation are not insisted on, there will be less difficulty in securing that all plague deaths should come to the notice of the sanitary authority under conditions allowing of the subsequent disinfection of every house in which a plague death has occurred.

Measures to obtain information regarding all plague deaths of greatest importance; neglect of such measures justified only in special circumstances

4. It is in particular with regard to the necessity of taking steps to ensure that complete information shall be obtained with regard to the occurrence of plague deaths that we find ourselves in disagreement with our colleagues.

We, for our part, are convinced that a plague policy which makes no effective provision for the discovery of plague deaths is a policy which is foredoomed to failure; foredoomed to failure in places where strenuous efforts are made to isolate the sick, and even more so in places where the efforts which are now made to isolate the sick shall have been abandoned. The alternative policy which, in our opinion, should be applied to the case of Bombay City, and, unless where special circumstances forbid, in the case of all other large towns, is one which should ensure the discovery of all suspicious deaths and the effectual disinfection of the houses in which suspicious deaths have occurred.

Let us place clearly before us that to abandon compulsory isolation of the sick, and to acquiesce in a plague policy which makes no effectual provision for the discovery of plague, is to acquiesce in a system under which isolation will never be resorted to, and under which disinfection will be applied to the houses only of those who volunteer the information that they have been infected with plague. Justification for such a policy would, in our opinion, exist only if there was any serious doubt as to the possibility of checking plague in cases where complete information of plague deaths and adequate disinfection arrangements are available, or if, on the other hand, there were strong reasons to believe that the application of the measures required for the discovery of plague deaths would in a particular place, or in a particular set of circumstances, entail disadvantages on the community which would be more serious than the disadvantages associated with the prevalence of the plague.

We propose briefly to consider these objections, which are the only objections which could be brought against the policy proposed by us.

The discovery of all plague deaths, and the disinfection of houses in which they have occurred, would be successful in combating plague.

5. We may begin by considering whether there is any reasonable doubt that, even after abandonment of isolation, success would attend such a policy.

We think there is no reasonable doubt that this policy, even without the aid of any measures of isolation of the sick, or of contacts, would be successful—we do not say in extirpating plague, but, at any rate, in holding its ravages within check. We cannot appeal to direct experience to show that this result would follow. It is true that we have instances, such as Hardwar and its neighbouring towns and villages, and Poona Cantonment in the second epidemic, where a complete, or all but complete, success attended the adoption of a policy which had as its cardinal features the discovery of all plague deaths and the disinfection of all houses in which plague deaths had occurred. Still, these cases are not directly applicable to the resolution of the problem before us, inasmuch as measures were also taken for the isolation of the sick and contacts.

In default of actual experience to guide us in this matter, the following considerations will enable us to gauge, to some extent, the degree to which the complete plague policy, which was proved so effectual in the instances referred to, would be rendered less effectual by the abandonment of all efforts at isolation.

(1.) It has not, in the case of any single town, been possible to find all the plague cases during life, but, of the cases which were found, there were very many who were discovered and isolated only when they were either moribund or in the very last stages of the disease.

It follows that what is abandoned, when all measures of isolation are abandoned, is not the isolation of all plague cases, but the isolation only of those cases which can be found.

Para. 213 of this Report.

(2.) In the case of those who are suffering from bubonic plague uncomplicated with lung symptoms—and these constitute a large number of the total of plague cases—plague bacilli have only in the very rarest cases been found in the excretions of a patient before that patient becomes practically moribund. We may, therefore, assume with probability that such patients are not infective in the earlier stages of the disease. If this is really so, it would follow that to postpone the disinfection till after the patient has succumbed is to postpone it for only a few hours after the time at which that disinfection first becomes necessary.

Para. 659 of this Report.

(3.) Inasmuch as the disease generally runs a very short course to death, and inasmuch as the bacilli—at least in cases of bubonic plague uncomplicated with lung symptoms—escape from the body of the patient only very shortly before death, and inasmuch as, further, the bacillus is capable of surviving for a very long period outside the organism, it will be manifest that the chances of plague infection being contracted from a bubonic patient during the life of that patient are relatively small compared with the chances of the infection being acquired from the room after the death of the patient. Thus the risk to the co-inhabitants of the dwelling will not, in cases of bubonic plague, be very much greater in cases where disinfection is instituted immediately after, than in cases where it is instituted before, the death of the patient.

Inefficiency of existing system of obtaining information of causes and place of death at burning and burial grounds. Paras. 585 and 596 of this Report.

6. The system which is adopted in Bombay, and in the other large towns of India, for the purpose of obtaining information with regard to the place and the cause of death has already been described. As explained by our colleagues, subordinate Native officials are posted at the burning ghauts and burial ground with a view to their eliciting the required information from the funeral parties.

We need not dwell on the fact that the information as to the cause of death, which is collected in such a manner, and through such an agency as this, must be, and indeed is, grotesquely inaccurate. This is everywhere conceded. Neither need it again be pointed out that where the relatives have any motive for concealing either the locality or the cause of death—and such motives will continue to be operative as long as any plague measures are adopted—there will never be any difficulty in throwing the authorities off the scent. We may, however, insist on the fact that all the attempts which have been made to render this radically vicious system of death registration effective have failed to achieve this object. For even when the police were given gratuities for reporting the place of origin of the burial party, and even when men were employed at the graveyards and burning ghauts to follow back the relatives to their houses, and even when the authorities availed themselves, in addition to the information which was obtained from the volunteer agency which is described in Section II.(1)(*d*) of Chapter VI., the place of death remained in many cases unknown.

System of special inquiries by medical men into causes of death not successful. 25,617.

7. Again, even when the elaborate system of special inquiries by medical men, which has been referred to by our colleagues, was resorted to, the cause of death in many cases remained unknown. We were told by Mr. Du Boulay, I.C.S., who was in charge of the plague operations in Bombay City, that he estimated at 259 the number of plague deaths which escaped discovery in the week ending the 4th March 1899. The estimated number of plague deaths for that week was 1,661. Taking these computations as very close approximations to the real numbers, and the week chosen as a typical week, the number of plague foci left undetected in Bombay corresponds in each week to one-sixth of the total plague deaths. Even if we were to omit from consideration all other possible means by which the plague is kept alive, we shall find in these undiscovered foci alone sufficient cause to account for the continued prevalence of plague in Bombay. If we now take it that each of these foci of plague may set up, when the external conditions are favourable to the survival of the plague bacillus, five or six cases of plague on an average, before the infective material is destroyed by the disinfecting agencies of nature, we should arrive at a total of plague cases comparable to that which is recorded week by week for Bombay.

Under present system, in spite of better disinfection, plague mortality in each successive epidemic in Bombay City increases.

8. It will be seen, on a comparison of the curves set forth in the chart given in Appendix No. LXXXIV. to our Proceedings for three successive years, that in Bombay City the total plague mortality was greater in the second epidemic than in the first, and greater again in the third than in the second. It seems probable from the records of the epidemic of 1899–1900, so far as these have reached us, that the total plague mortality in the fourth epidemic may exceed even that of the third. This, we may note, is occurring in spite of a steady improvement in the methods of disinfection which are applied to discovered cases.

Seasonal variations in Bombay not influenced by plague measures.

9. Again, if we turn and examine the features of the curves of individual years, we shall see that there is in each year an extraordinary seasonal increase in the plague mortality, which is followed by an equally remarkable seasonal decrease. In each year the mortality begins to rise in the later months of the year, and then rises steadily till February or March, when it begins again to decline.

Now inasmuch as disinfection operations are continued throughout the year, and inasmuch as they are not carried on less vigorously during the period of the year when plague mortality is on the increase than during the period of declining plague mortality, it will be manifest that we must impute the increase and decline of plague, not to the lesser or greater efficacy of the disinfection operations and other measures which are applied by the plague authorities to the discovered foci of plague, but to the lesser or greater efficiency of the natural disinfection agencies which came into operation without the intermediary of the plague authorities upon the undiscovered foci of plague. The more these facts are considered the more, in our opinion, does the necessity for taking steps, wherever plague is rife, to secure that all plague deaths shall be discovered, enforce itself upon the mind.

Death registration accompanied by disinfection in all cases where cause of death not ascertained a possible means of dealing with plague, but involves unnecessary disinfections. 10,989–94. 14,631.

10. When we turn to the question of seeking a remedy for the concealment of plague deaths which now exists, consideration shows that the only possible way by which the place of death could be ascertained would be to render it penal to proceed to the removal of any corpse until the death had been notified and a permit had been issued by the sanitary authority. Only in this way would it be possible to locate every death. Major Ross, who has had considerable experience both in Poona and in Bombay, has suggested that it would be well to provide that all deaths should be registered within a period of, say, six hours. This first step having been taken, it would be necessary to follow this up by taking steps to ascertain the cause of death in each case, or, failing this, to disinfect every house in which a death from any cause occurred. This was done at one time in Baroda. But to do this in the City of Bombay would, taking into consideration the ordinary rate of mortality in Bombay, involve the institution of some 500 disinfections per week, which would be unnecessary so far as plague was concerned. If only for the sake of avoiding the unnecessary expense and the hardship which would be inflicted on the people by these 500 disinfections, it would plainly be well to have recourse to some method of discriminating the deaths due to plague from the deaths which are not due to plague.

Sources of accurate information of cause of death.

11. It will be manifest that hearsay evidence based on inquiries from relatives or others, and conjecture based on the occurrence of two or more cases of deaths in the same house within a short period, will supply only inaccurate, and in many cases also

belated, information. There will thus come into consideration, for our purposes, only medical information based on examination of patients during life, or medical information based on examination after death. The former will be available in the form of death certificates signed by unofficial medical practitioners, and the latter can be based on an examination of the body after death conducted by official medical men.

Death certificates of little practical use in the past. Paras. 582–4 of this Report.

12. With regard to death certificates, it has already been noticed by our colleagues that very little information has been derived from this source. This, as has been seen, is due to several causes. In the first place, only a very small section of the population is attended by medical men. In the second place, the obligation to report deaths from plague has not generally been imposed upon practitioners even in plague-infected Municipalities. In the third place, even when the obligation has been imposed, this has not been generally enforced, while a powerful motive in the form of loss of practice has rendered practitioners unwilling to report deaths as due to plague. Again, it imports us to note that, as many persons of very inferior medical education are in India popularly included within the ranks of medical practitioners, many of the certificates must be regarded as practically worthless. Lastly, let it not be forgotten that, owing to the desire of the patients and their relatives to escape the imposition of onerous plague measures, false medical certificates have often been put forward for the purpose of concealing the fact that death has been due to plague.

Owing to these causes, medical certificates which ought, in conformity with the greater facility of arriving at a diagnosis during life, to supply the more valuable information, have, as a matter of fact, supplied very little useful information with regard to plague deaths.

Means of improving system of death certificates.

13. While we recognise that this source of information cannot, under any circumstances, be rendered fully available in India, we think that every endeavour should be made to make it more fully available and more trustworthy than it has been up to the present. We think that this result would be brought about spontaneously with regard, at any rate, to that section of the population which is attended by medical men, if a policy were adopted under which the notification of plague ceased to involve either compulsory removal to hospital or segregation of the contacts, and under which corpse inspection, or, failing it, disinfection, was insisted upon in every case where the presumption that death was due to plague was not rebutted by a medical certificate from a reputable practitioner. Further, we would point out that, given such a policy, it would at all times be possible largely to increase the amount of information available from this source by providing medical men who should visit cases of sickness and issue certificates to them which could, if these cases issued fatally, be used as death certificates. Arrangements on these lines for supplementing the information derived from ordinary death certificates, and for reducing the number of necessary corpse inspections, were, as a matter of fact, made in various places, among others, in Poona and Cutch Mandvi.

21,984–999. 13,552.

Corpse inspection; outline of policy recommended.

14. Failing information derived from medical death certificates, there is no source, except corpse inspection, from which the required information could be obtained.

Before proceeding to discuss the question of the efficacy of this measure, and the further question of the attitude of the people with regard to it, and finally, the question of the expediency of introducing it, we think it well very briefly to state our attitude with regard to this measure. While we think that every European Medical Officer of Health ought to be empowered, failing the production of a medical certificate, to proceed to corpse inspection, we are far from thinking that this practice should be resorted to to the prejudice of more important interests, and, indeed, we do not contemplate that corpse inspection should be adopted as a general measure, except in places where the Public Health is threatened by epidemic disease. Possibly, under certain circumstances, it might occasionally be wise for the Sanitary Officer to stop short of the actual inspection of the corpse. He might then content himself with classing the death as suspicious, and proceed to the disinfection of the house.

Means by which information can be gathered by corpse inspection at the place of death.

15. So much having been said in the way of preface, we may pass to consider the question of the efficacy of corpse inspection as a measure for the detection of plague deaths. What is necessary to say on the question may be said in a very few words.

It may be pointed out, in the first place, that just as in the case of medical examinations of the living, so in the case of corpse inspection conducted at the place of death, information will naturally be gleaned, firstly, from the consideration of the history as detailed by the relatives; secondly, from the inspection of the surroundings of the patient (in illustration of our meaning it will suffice to refer to the fact that a valuable inference could be drawn from the fact that there were other sick persons in the house); and thirdly, from the objective signs noticed on the corpse. It may be noted in passing, that the fact that information can be gleaned from all these sources only if the inspection is done at the place of death would indicate the necessity of conducting the corpse inspection there and not, as has sometimes been proposed, at the burning ghauts and burial places.

The fact that there will be a percentage of error not a reason for rejecting corpse inspection more than medical examination during life. Paras. 594–6 of this Report.

16. The next point of general consideration which must be kept in view in connexion with corpse inspection is that, just as we must expect a percentage of error in the diagnoses arrived at by medical examination during life, so there must similarly be expected to be a percentage of error in the diagnoses of plague after death. In view of this, we do not think that diagnosis by corpse inspection ought to be discarded, as our colleagues would seem to suggest, any more than we think that diagnosis by examination of patients in life ought to be discarded, because it is, in many cases, impossible to arrive at a diagnosis as to the existence of plague by such an examination. And, in particular, in view of the fact that plague pneumonia is one of the most difficult diseases to diagnose in life, we cannot see that there is any reason for rejecting corpse inspection, on the ground that, in many cases, pneumonic plague cannot be diagnosed after death. Lastly, we need, perhaps, do no more than glance at the argument that has been advanced to the effect that diagnosis by corpse inspection will give, at best very uncertain information when it is committed to unskilful and uneducated classes of practitioners. This consideration will obviously apply with not less force to medical examinations conducted during life.

Services which corpse inspection is capable of rendering.

17. To come to the essential point, it cannot be denied that diagnosis by corpse inspection, like medical examination during life, if committed to medical men having a sufficient knowledge of their profession, will, on the one hand, lead to the detection of the large majority of cases of plague, and, on the other hand, will enable us frequently to differentiate suspicious cases from unsuspicious cases among the residuum of deaths.

Objective signs of plague in corpses.

18. It may, perhaps, be well here to detail the objective signs which seem to us to be of greatest importance in establishing the diagnosis of plague by inspection of a corpse.

In the large majority of cases of bubonic plague a diagnosis can readily be established, even after death, by noting (1) the presence of buboes, (2) the presence of œdema in the region of these buboes, (3) the occasional presence of a purpuric eruption or of patches of subcutaneous blood effusion over the buboes and under the conjunctiva, and (4) in certain cases the existence of plague carbuncles or plague blisters. Of less diagnostic importance, but still of considerable value, will be (5) the furred condition of the tongue, which, while comparatively clean round the edges, will generally be covered in the centre with brown or blackish fur, (6) the high temperature of the body when seen soon after death*, and (7) the comparatively well-nourished condition of the body.

In the case of septicæmic plague we have as objective signs, in most cases, only the appearance of the tongue, the high post-mortem temperature, the comparatively well-nourished condition of the body, and, possibly, evidence of the occurrence of hæmorrhages.

In the case of pneumonic plague we should probably have, in addition to the characters of septicæmic plague, also the presence of frothy blood-tinged sputum about the person, or in the neighbourhood of the corpse. Further, as the observations of Captain Elphick and Captain James show, œdema may in some cases be found on the front of the chest. 9544–9. 10,344–6.

Attitude of the people towards corpse inspection; review of the conclusions drawn by our colleagues. Paras. 587–92 of this Report.

19. We may now pass to consider the question of the attitude of the people towards corpse inspection. The evidence on this question has been reviewed by our colleagues in Section II. (2)(*b*) of Chapter VI., and it has already been shown that there has not in any single instance been serious opposition offered to the practice. We take it from the fact that our colleagues have omitted to refer to the case of the Bombay riots of March 1897, that, in their opinion, these riots were connected rather with other plague measures than with the proposal, which had at the time been discarded, that corpse inspection should be introduced. So far as the evidence on this matter has been placed before us, we are in agreement with what we take to be our colleagues' opinion.

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* We are indebted to the courtesy of Captain Beveridge, R.A.M.C., for information with regard to a case of plague, in which he observed a post-mortem rise of temperature from 108° to 112° F.

In certain cases, however, we have, from the evidence placed before us, formed a different opinion from our colleagues. Thus, for instance, in the cases of Karachi, Hyderabad (Sind) and Kotri, we think it important to note, not only the fact that corpse inspection 'was not objected to,' but also the further fact that, after the panic which followed immediately upon the first outbreak of plague had subsided, the people 18,133. "were," said Colonel Henderson, I.M.S., "entirely with us." Similarly, in the case of Cutch Mandvi, we think it important to note that, although Major Hyde Cates did 'mention incidentally that the relatives very much object to their dead being examined,' this statement must be taken in connexion with the fact that the same witness also stated, in response to one inquiry, that he had "had no bother at all 13,550–1. with the natives," and, in response to another inquiry, that "the Muhammadans—the class who would be most likely to object—did not object at all." It has also to be taken in connexion with the fact that Captain Mason, R.A.M.C., who was engaged on 27,174–6. plague duty in Cutch Mandvi, stated that no opposition of any kind was offered by the natives to corpse inspection. Lastly, in connexion with Mr. Gidumal Lekhraj's statement that 'the people objected to corpse inspection, even although it is well-conducted, "because it is against the Muhammadan and Hindu religions to touch a 15,521. corpse after death,"' we think that it is well worthy of consideration whether the opinion of this native witness may not have been unconsciously influenced by the form of the question which was addressed to him.

Our own conclusions regarding the attitude of the people.

20. Just as we differ from our colleagues with regard to the conclusions which are to be drawn in these particular cases from the statements of the witnesses, so we differ from them also with regard to the deductions which are to be drawn from the whole body of evidence which was put before us with regard to the attitude of the people to corpse inspection. For our part we draw the following conclusions from that body of evidence with regard to the attitude of the people on the subject of corpse inspection:—

We are of opinion that there is nothing in the evidence which has been placed before us to show that there is anything in the practice of corpse inspection which is generally repugnant to native opinion. It appears to us that, in certain cases, at any rate, such a feeling is perfectly absent from the native mind. In support of this opinion we would refer to the experience of Lieutenant Steen, who was engaged on plague operations in the Satara district. That experience, as stated in answer to a question by one of our colleagues as to whether, "though the people may not have made any" actual opposition, there may not have been something in the practice "which was offensive to their feelings," is as follows: "No, I do *not* think corpse 22,748–9. inspection is offensive to their feelings. They show their corpses quite freely, both male and female. Before death, also, I have often examined both male and female patients, and have never noticed that my doing so was offensive to their relatives. The people are often quite callous as to what is done with their sick and dead." Again, Mr. Cadell, who had experience of corpse inspection in Karachi, when interrogated by one of our colleagues with a view to the elicitation of any facts which might point to the existence of a feeling of repugnance to the medical examination of the dead, and in particular to the examination of female corpses, 3805–7. replied as follows: "I do not think they regard the dead with anything like the same degree of respect that they do the living."

We are aware, of course, that it is not possible to generalise from experience in these cases, and we think that it is impossible to doubt that the people in many places may have disliked corpse inspection. But we take it that, where such dislike exists, it has not differed in anything from the dislike which was felt to all other plague measures which interfered with the people in any way. And if we may judge of the antipathy to a measure by the amount of active or passive resistance which has been evoked by it, we think that the feeling against corpse inspection has not been nearly so intense as the feeling against the compulsory removal of the sick to hospital, or against the segregation of contacts, or, lastly, as the feeling against evacuation in places where this involved either the interruption of trade or the taking of pardah women into camp. In support of this opinion, we may note that Lieut.-Col. Nariman, I.M.S., stated that in Surat, where corpse inspection was resorted to whenever the Vigilance Committee thought it necessary, the measures to which the 15,865. people objected most were "evacuation and segregation." The same opinion was expressed also by Assistant Surgeon Dadachanji who had experience in Bulsar, where 16,169–72. all corpses were examined. He was asked, "What do you think is the measure that 16,232. people object to most?" and replied, "From the Indian's point of view, separation of the sick is objectionable." Neither of these witnesses mentioned corpse inspection as a measure to which the people objected. In addition to noting the above opinions we may note also that in the Punjab the people "did not object in the least anywhere," 10,253. though corpse inspection was resorted to in a number of villages, and was "carried regularly on for some time" at Banga, a small town of 5,000 inhabitants, a place of which the people "were noted for being exceptionally troublesome," and where con- 10,235. siderable opposition was offerred to the authorities in connexion with evacuation. While corpse inspection was thus carried on without opposition, and while we learn from Captain James' Report that the plague officers "frequently obtained permission to Capt. James' Report. open glands after death for the purpose of bacteriological examination," the opposition to evacuation was in many cases extremely serious; in the case of Garhshankar, this opposition culminated in a riot, in which 9 persons were killed and 35 wounded. In comparison with this, all the objections which have been offered to corpse inspection would appear to be insignificant.

Specific instances of objection to corpse inspection and cases showing absence of antagonism to it.

21. The only specific instances which have come to our knowledge of objections being raised to corpse inspection are the few instances enumerated by our colleagues in connexion with the inspection of the corpses of pardah women, one further such case at Sholapur, and one instance at Poona, where the body of a fakir was in question. The objections in the first class of cases were easily got over, in some cases by the employment of a nurse or a lady doctor, in other cases without a Para. 588 of this Report. resort to such measures. The objection in the case of the holy man was readily 23,884, 21,373. got over by the employment of a Brahman doctor.

In addition to pointing out that the instances referred to are the only specific instances which have come to our knowledge of the raising of serious objections, we would further note that we have evidence that in certain cases, where the people have become familiarised with the practice, and especially, we may take it, where they have appreciated that the practice may save them from the institution of unnecessary disinfections, the native feeling has been rather favourable than antagonistic to corpse inspection. We take it from what we personally saw of corpse inspection in Poona, together with what we heard from the witnesses there, that this was the attitude of the people in Poona.

We have already stated that the people were, we were told, generally favourable to corpse inspection in Karachi, Hyderabad (Sind), and Kotri. Nor is evidence wanting that corpse inspection is not viewed with aversion by, at any rate, certain sections of the population in Calcutta and Bombay. We would point, in this connexion, to the fact that corpse inspection was often, as Dr. Nield Cook tells us, 6514. permitted when the Medical Officers went to make inquiries about cases of suspicious death. In the case of Bombay, we would point to the fact that Mr. Macdonald, who has already been quoted by our colleagues, found that the natives did not object to 17,968. their corpses being examined by him. He said, "My experience is that they are quite willing that a European should do it, but they do not like dark persons to examine them if they are of another faith." With regard to this last statement, however, we would point out that corpse inspection was carried out without objection Para. 595 of this Report. by Hospital Assistants, not only in the several places enumerated by our colleagues, but also in the towns of Hubli, Bhiwanda, and Bhagda. We take it that these Hospital 3077, 22,185–8, 16,199. Assistants must have examined the corpses of many persons "of another faith," and in some cases they are specifically stated to have examined female corpses.

We may note that it is difficult to suppose that the objection to corpse inspection can be greater in India than it is in a Muhammadan country like Egypt, where corpse inspection has been carried out most efficiently for the last half-year without hitch or difficulty. In Alexandria, for instance (and the population of Alexandria is notoriously turbulent), no one is now buried without having been seen either during life or after death by a qualified medical man.

The expediency of corpse inspection in large towns.

22. Having now, so far as we can, summarised what seems to us to be the real teaching of the experience of the past with regard to the attitude of the people towards corpse inspection, so far as it has been disclosed to us in the evidence laid before us, we may proceed to consider the question of the general expediency of the measure. We do not propose here to consider the question of the expediency of resorting to corpse inspection in the cases where plague is present, or where it is suspected to be present, in villages and in smaller towns. For we take it that, given that the necessary staff is available, the expediency of resorting to corpse inspection in such places will not be in question. What we do propose to consider here is merely the question of the expediency of resorting to the practice of corpse inspection in the larger towns. In connexion with this we have to refer again to the expediency of taking the necessary measures to secure that the body shall not be carried out from the place of death until the death has been reported and a permit to remove it has been issued.

Para. 596 of this Report. Our colleagues have, as has been seen, declared themselves to be of opinion that corpse inspection is, in the case of large towns, and in particular in the case of Calcutta and Bombay, an impracticable measure. They recommend that no change should be made in the present confessedly very defective system of death registration.

The opinion of Surgeon-General Cleghorn, late Director-General of the Indian Medical Service, is practically identical with that of our colleagues, unless perhaps in the fact that the advantages of corpse inspection appeal more strongly to him. His opinion will be gathered from the following extract from our proceedings:—

26,732. *Q.* "Do you think that infective disease will never be successfully combated until you get a system of death registration?"

A. "That is so."

26,733. *Q.* "And until you ascertain the causes of death?"

A. "Yes, but that is practically impossible."

26,737. *Q.* "Do you think it would be possible to pass laws and to make it penal to move or dispose of corpses before they had been examined?"

A. "I think it would be very difficult to do that."

26,738. *Q.* "Do you think it is only playing with plague to attempt to deal with it without introducing corpse inspection?"

A. "That is the cardinal measure before sanitary and preventive measures, if you can get it. Of course, the difficulty was how we could do it."

Similar is the opinion of Mr. Lund, a merchant of Bombay, who also has been quoted by our colleagues. Mr. Lund, while he thought that more cases of plague 17,886. might be detected by corpse inspection, was of opinion that it would be inexpedient to resort to this measure. The mental attitude of this witness may be gathered from the fact that he was of opinion that it was like "ploughing the sand" to attempt to 17,887. deal with plague in Bombay, "one can, after all, only do one's very best, and trust to Providence for the result. . . . The quieter you keep the people the better."

Our colleagues have further quoted Dr. W. Venis as being of opinion that corpse 19,924; 19,928. inspection could not be adopted in Bombay. A reference to the evidence will show that Dr. Venis qualified his opinion, and that he stated that he had had no experience of plague in Bombay.

Major Ross is further cited by our colleagues as being of opinion that corpse inspection could not be adopted in Bombay. A reference to the evidence will show that although this is Major Ross' opinion, the witness who had a wide experience of plague operations both in Bombay and in Poona was so impressed with the fact that "plague 10,986–94. is spread only by the undetected cases," that he has insisted on the necessity of every death being reported before the corpse is carried out, and further on the expediency of widely extending the system of death certification by providing a sufficient medical staff to visit all the sick who are not attended by private medical men. Under the scheme which is proposed by Major Ross, every house, in which there occurred a death which had not been certificated, would, as a matter of course, be promptly disinfected.

In connexion with the question of the adoption of a system of corpse inspection in Bombay, our colleagues finally quote the opinion of Mr. Du Boulay, I.C.S., who was in charge of the plague operations in Bombay, under the Municipal Commissioner. Mr. Du Boulay is quoted by our colleagues as thinking 'that more complete information *might* (the italics are ours) be obtained from corpse inspection, but that it would cause much opposition.' In view of the ambiguity of the auxiliary verb employed in the first clause of this quotation from our colleague's Report, it may be well to quote from our proceedings the exact questions and answers which our colleagues have in view. These are as follows:—

25,618. *Q.* "Could you not receive more complete information than you do at present by a system of corpse inspection?"

A. "Undoubtedly."

25,619. *Q.* "Do you think corpse inspection would arouse much opposition?"

A. "Undoubtedly it would."

25,620. *Q.* "Do you think it would arouse less opposition if conducted at the graveyards, or burning ghauts, than if conducted at the houses?"

A. "I think it might be conceivable by very very slow processes to arrive at a certain amount of compulsion that they should be examined in the houses, but it would be a very slow process, and probably take a couple of years to work up to."

25,621. *Q.* "Do you feel inclined to think that a system of corpse inspection should be gradually introduced; do you think it would be wise and that it would be an advantage to introduce it?"

A. "Yes."

The opinion of Dr. Nield Cook, showing within what limits he thought it would be expedient to introduce it in Calcutta, has already been quoted by our colleagues. So has the opinion of Mr. Winter. This, again, is, in our judgment, distinctly favourable to a resort to corpse inspection, in the case of plague-infected cities in Northern India, provided always that this were done with tact. 6605-7. 9247.

Recommendations.

23. We for our part are, as we have already said, convinced that it is essential to introduce corpse inspection into the large towns if it is seriously intended to deal effectually with plague there. We have also, after weighing as carefully as we can the evidence which has been laid before us, arrived at the opinion that it is expedient to resort to a general measure of corpse inspection in the case of large cities when seriously infected with plague, and, in particular, that it would be expedient gradually to work up to the adoption of such a measure in Bombay. We have gathered from the evidence which has been placed before us—and we have especially sought information on this point from the Bombay Government—that the resistance which has been actually experienced on introduction of the measure has always been much less than appears to have been anticipated. We have gathered further that wherever objections have been raised to the practice, these have always been dispelled by providing a lady doctor or a nurse where the objection happened to take the form of an objection to the examination of female corpses, or, when it took a more general form, by providing facilities for the sick being seen in life with a view to death certificates being provided by doctors officially appointed for those who are not attended by private practitioners, or, lastly, when the difficulties could not be met in this way, by treating the case as a suspicious one and by disinfecting the house.

When we pronounce ourselves satisfied of the expediency of introducing corpse inspection and of carrying it out as a general measure in a town where the loss of life is as great as it has been, and still is, in Bombay, we do not propose that corpse inspection should be carried out at once as a general measure in towns like Calcutta, where plague has up to the present shown itself to be less dangerous to the Public Health than many other of the ordinary infective diseases. What we would, however, insist upon as being in our opinion absolutely essential is that, in every town which is or shall in the future be provided with a European Medical Officer of Health, a system of death registration should be introduced which should be effectual in locating every death. Only when this shall have been done will it be possible to take effective measures in the form of corpse inspection on the outbreak of a serious epidemic of plague or other zymotic disease.

Concluding remarks.

24. We hold that to appoint Medical Officers of Health, and leave them unprovided with the means of obtaining the information which is to be a basis of all measures taken against infective disease, is to adopt a policy of appointing Medical Officers of Health who will necessarily be powerless to arrest the spread of epidemic disease. We hold, in particular, that where the power of resorting to corpse inspection is withheld from the Medical Officer of Health, that Medical Officer ought, *ipso facto*, to be entirely relieved from all responsibility for the success of the measures taken, unless perhaps in cases where he is authorised to disinfect every house in which a death occurs. While we recognise that there may quite well be special circumstances where, owing to the fact that other interests may be jeopardised which are more important even than those of the Public Health, it will perhaps be necessary occasionally to withhold the power of corpse inspection, we would point out that, until corpse inspection, in default of medical certificate, is introduced, there is only too much reason to believe that most of the money spent on plague measures will be wasted. Further, we think that, given the case that plague were to cease to be epidemic in Bombay, Calcutta or any other sea-port town, it would be necessary, failing the reform of the present system of death registration in these towns, to continue to enforce the present regulations for the prevention of the spread of plague oversea, and that for a very prolonged period. We do not see how, on a system under which over three-fourths of the dead are disposed of without being seen by a medical man, it would in the future be possible to declare a particular port to be free from plague.

A. E. WRIGHT.
M. A. RUFFER.

APPENDIX V.

Note by the President regarding the Efficiency of Measures of Disinfection which have been adopted, with a Statement of the Measures recommended by him for dealing with Plague, disagreeing with certain of the Conclusions arrived at by the majority of the Commission.

A.—Instances advanced in proof of the preponderating value of disinfection by chemical substances are insufficient to do so.

The evidence adduced is insufficient to show that chemical disinfection has had a preponderating effect in destroying plague infection.

1. The President is unable to agree with the opinion expressed in paragraph 671 of the Report, that where skilled and efficient control was exercised in the operations of disinfection, as under the supervision of Captain James, I.M.S., of Col. Fawcett, R.A.M.C. and Major Ross, D.L.I., and of Mr. Winter, I.C.S., there is little doubt "that chemical disinfection exerted a preponderating influence."

It was impossible effectively to control chemical disinfection in the Punjab, and chemical disinfection there was not alone trusted to, but was accompanied by other measures.

Capt. James' Report, pp. 111, 16, para. 36 and 37; 116; 112.

2. In Captain James' Report on the outbreak of plague in the Jullundur and Hoshiarpur districts of the Punjab, it is stated that the strength of the phenyle emulsion used in the disinfection operations was determined, not by accurate measurements, but by adding phenyle to water until "a dense white fluid looking like milk was obtained." The disinfectors were "for the most part village menials"; it was only to a very small extent practicable to employ permanent disinfectors; "the immediate supervising agency consisted ordinarily of Hospital Assistants"; and Captain James has observed that "when the Inspecting Officer came on his rounds, a few hours after the disinfectant had been sprayed on the buildings, not a sign of it could be seen, so that there was practically no means of verifying the fact that the process had actually been performed." Chemical disinfection, further, was not alone trusted to, but was accompanied with total evacuation, which was "carried out on a very large scale in the Jullundur and Hoshiarpur districts," and with the making of large ventilation holes in the roofs of all non-infected houses and the removal of the entire roof of infected houses.

Chemical disinfection in Poona and Kirki accompanied by opening up houses and other measures.

21,289; 21,290.

21,251-253.

3. In Colonel Fawcett's description of the method of disinfection followed in the Poona and Kirki Cantonments, it is stated that "every house in which a case occurred had the roof or a portion of it removed," and all rags and rubbish were burned before the house was chemically disinfected, while a considerable number of the houses were demolished. Further, when plague broke out in several Native Regiments, they were removed into camps on new ground, without any disinfection, and the outbreak soon ceased. The instance in which special care was taken in the disinfecting operations appears from the evidence to have been that in which several cases of plague re-appeared in the Transport Lines among the followers and their families, after they had been removed to camp because of an outbreak of plague. The camp was thereupon transferred to a new site a few yards distant, "each tent was sprayed with perchloride of mercury solution, then carried across the road and put up; the followers and their families, including even their cats and dogs, their cocks and hens, were carefully disinfected before being allowed to cross the road and re-occupy their tents." Although the experiment is stated to have been eminently successful, two cases of plague subsequently occurred. It may be added that Colonel Fawcett disclaims responsibility for a part of the extreme application of chemical disinfection adopted in this instance.

21,254.

21,257.

21.254-5.

Major Ross, Durham Light Infantry, who is also referred to, stated, that in Poona, disinfection with non-acidified perchloride of mercury was at one time inefficiently, but latterly efficiently, carried out, and, in his opinion, it became absolutely effective from that time. This chemical disinfection, however, was conjoined not only with the removal of the patients and all contacts from the infected houses, and with the evacuation of considerable adjoining areas, but also with disinfection by sunlight and free access of air, for "the roof was taken off to let the sun in."

10,930.

10,914-16.

10,921.

10,933.

Soon after Major Ross assumed duty in the Poona Cantonment, it was found by Colonel Fawcett that the solution of perchloride of mercury which was being used in the disinfecting of houses and clothes had been made from an impure preparation containing much insoluble matter. The error was corrected, and the mixing of the solution was afterwards "personally superintended" by Colonel Fawcett; and this, apparently, constituted the conjoined action of Colonel Fawcett and Major Ross, referred to in paragraph 671. It is to be noted that the corrected and approved solution of 1 in 1,000 of perchloride of mercury was made without the addition of any

21,305-10.

10,930.

10,931.

acid, although it has been indicated, on experimental data, that such a solution 8555-4; 8580;
is not only "absolutely useless" when applied to earth and cowdung floors, but 18,828,
may lead to an "apparent increase" in the number of microbes by adding to the Para. 652 of our
floor the water of the solution, while the perchloride of mercury is itself neutralised by Report.
many of the constituents of the floor.

Major Ross, however, was unable to say if any cases of plague occurred on the
re-occupation of the chemically disinfected houses from which patients and contacts 10,937.
had been removed. On the other hand, in Igatpuri, where a similar error was
committed, and is instanced in paragraph 670 as an example of the failure of chemical
disinfection resulting from the employment of too weak a solution of perchloride of
mercury, there is clear evidence that the substitution of a solution of the approved
and intended strength (1 in 1,000) did not produce any beneficial effect on the progress
of the outbreak. The solution of insufficient strength (1 in 10,000) was used during
the greater part of August 1897, and the plague attacks and deaths were 123
and 85 respectively. The solution of approved strength was used during September,
and in that month the plague attacks were 292, and the deaths 251. Apart from 23,317.
the mistake in the first preparation of the solution of perchloride of mercury, the disinfecting operations appear to have been conducted with much care: "A disinfecting
party, under an Assistant Surgeon, who had been working at disinfecting work in
Bombay, was obtained at once, and thorough disinfection with corrosive sublimate
solution was carried on." This case is specially instructive in so far that no other
plague measure but chemical disinfection was adopted, on "the theory of disinfecting
the house, its inhabitants, and their belongings, and allowing them to re-occupy the
house at once." The result was disastrous; and plague continued to extend until
complete evacuation of the village was carried out, before which several chawls "had 23,196
been disinfected four or five times, and still cases occurred" in them.

Evacuation and prolonged vacation of houses the principal measures adopted in the North-Western Provinces.

4. Mr. Winter, I.C.S., deals in his evidence with the Hardwar district, in which the
towns of Hardwar, Kankhal and Jawalapur, and several villages, were affected with
plague. In the towns of Hardwar and Kankhal the houses are well built and well
ventilated, and overcrowding is prevented by special regulations, enforced by frequent
inspections by the authorities. They are, therefore, exceptional among Indian towns,
in so far that the opening up of the houses to sunlight and air was not required as a
plague measure. 9005-7.
9013-5.

Hardwar.

The Hardwar outbreak was a small one, only 18 cases having occurred. On the
occurrence of the first cases, isolation of the sick and the contacts with disinfection of 9064.
the houses was adopted; but as these measures proved unsuccessful, compulsory and
voluntary evacuation was superadded, and carried to such an extent that only 9025-62.
500 people, out of a normal population of from 4,000 to 5,000, remained in the town.
It was only while the town was thus nearly emptied of its inhabitants, and actually 9045-50.
after the outbreak had ceased, in the hot weather of June, that disinfection of all the
unaffected houses was carried out.

Kankhal.

In Kankhal, after the occurrence of three cases of plague, and of many deaths
among rats, an affected area was evacuated, and all the houses in it were disinfected
with perchloride of mercury. These measures, however, proved ineffectual, and 9090-9113.
ultimately, after continued failures following nine or ten subsequent partial evacuations
with disinfection of the unoccupied houses, the whole town was evacuated, and soon
afterwards the outbreak ceased. Further, the inhabitants were not allowed to return 9102, 9117.
to their houses until $3\frac{1}{2}$ months after the total evacuation had been accomplished.

Jawalapur.

In Jawalapur, also, the earlier measures were evacuation of successive areas and
chemical disinfection, but as cases continued to occur an attempt was made "to stop 9175.
the disease by the thorough disinfection of the whole town." This also proved 9173-4.
unsuccessful—it is incidentally stated that one case at least occurred in a disinfected 9176.
house—and complete evacuation was then adopted. "On the whole it was satisfactory," 9178.
although the evacuation was a voluntary one, and the people built their own camps
and overcrowded the huts.

Villages in the Hardwar district.

In the affected villages of the Hardwar district, the organisation which was employed
succeeded, in most of the villages, in discovering the first, or "at any rate one of the
very earliest cases in each village." In each of these villages a large area was evacuated 9134.
and the infected houses were destroyed by burning them, and outbreaks were thereby
prevented from occurring. In two villages in which the organisation was not so
successful, and where several cases of plague were simultaneously discovered, complete 9148.
evacuation was at once adopted: and in one of the two villages a few cases occurred in
the camps within a few days after the evacuation, and the outbreak then ceased; and 9167.

9168.

in the other village, cases continued to occur for a longer period before the outbreak ceased, owing to a failure in preventing intercourse with plague patients, and notwithstanding scrupulous care in disinfecting the clothes and other possessions of the patients with solution of perchloride of mercury.

Banga freed from infection by evacuation and prolonged vacation of infected houses rather than by chemical disinfection.

Capt. James' Report, pp. 30–34.

Capt. James' Report, p. 30.

Capt. James' Report, pp. 111–112.

10,172.

5. The experience of Banga, in the Punjab, is cited (paragraph 671) in support of the opinion that disinfection with chemical substances might succeed in destroying the infection of plague, irrespective of the influences exerted by the opening up and prolonged evacuation of houses, in cases where all these measures were used in combination. The method employed in preparing the solution of phenyle used in Banga has already been described (paragraph 2, *ante*). The town of Banga was partially evacuated on the discovery of the first case of plague, and the infected houses were disinfected; but as the disease continued to spread, even when these measures were repeated on three successive occasions during the months of March and April, the town was finally completely evacuated. As the re-occupation of the evacuated houses was not permitted until two months after the date of complete evacuation, the disinfection to which the houses had been subjected cannot be credited with the freedom of the inhabitants from further cases of plague. Although Captain James reports that "the usual ventilation holes" could not be made in some of the houses, and the authorities "had to trust to a plentiful application of disinfectants and limewash," and although ventilation holes were not made in the larger houses, which were already well lighted and were free from overcrowding, the long period during which they and all the other houses in Banga were left unoccupied prevents any conclusion from being arrived at regarding the value of the chemical disinfection to which they had been subjected. It is to be recollected that the words "in some of the larger double-storied infected houses in Banga, where we could not get direct sunlight through many of the rooms, and where the walls were made of rough brick, which did not take the lime-washing, we had to trust entirely to phenyle lotion made as here described. The result was quite satisfactory," relate to the limitation of the disinfection to the employment of chemical substances, as contrasted with the method, nearly always practised in Banga, of combining the disinfecting influences of chemical substances with those of sunlight and air, and that in the few cases in which, apparently, the disinfection was only by chemical substances no attempt is made by Captain James to eliminate the effects on the spread of the disease caused by prolonged evacuation of the houses. Besides, inoculation was adopted at the commencement of the outbreak, and a large number of the inhabitants had been inoculated before the complete evacuation of the town.

Criticism of case of Poona, and Major Ross' opinion regarding disinfection.

Report on Plague Operations in Poona Cantonment and Suburban Municipality.

6. The statement regarding Poona (paragraph 671) is not in itself complete, as it does not assert that people returned with impunity to their houses after the houses had been vacated for only ten days. On the other hand, there are many cases which show that occupation within so limited a period after disinfection with chemical substances has been attended with the most unfortunate results, and several of them have been cited in paragraph 632 of our Report. The experience gained in the Cantonment and Suburban Municipality of Poona—the parts of the City in which Colonel Fawcett and Major Ross directed the plague operations—is, however, unambiguously opposed to the practice of disinfecting houses and allowing the inmates to return to them ten days after the houses had been vacated. In a report submitted to the Government of India by the Committee under the chairmanship of Major-General Burnett, his experience is thus stated: "As the disease increased in virulence, the disinfection and evacuation of a house for ten days only was found to be quite useless. The houses still retained the infection and as sure as the occupants returned they were attacked by plague within a few days." Although more than 2,000 houses were disinfected, and although the strength of the solution of perchloride of mercury was increased from 1 in 1,000 to 1 in 500, the results were "very disappointing"; and the Committee report that "it seems proved that, after the most careful disinfection, it is quite unsafe to allow a house to be re-occupied after a period of ten days."

10,972.

In paragraph 671, also, the reply of Major Ross to Question 10,972 is adduced in corroboration of the opinion "that the freeing of the houses from infection might have been achieved independently of these measures," namely, "the opening up or the prolonged vacation of the houses." The question and reply, however, deal primarily with the relative values of lime and of perchloride of mercury in preventing the spread of plague when all the houses were systematically treated "through the Cantonment, irrespective of cases, taking street by street." The great majority of the houses, therefore, did not contain plague infective material, and the great majority, also, had not been opened up to light and air, for this was done only in houses in which plague cases had occurred. As no distinction is made between the effects observed in the several groups of houses, this evidence seems inadequate to support the opinion "that chemical disinfection exerted a preponderating influence in destroying the infection."

Report, para. 671.

7. The opinions expressed in paragraph 671, to which objection has thus been taken appear, therefore, to convey a very exaggerated estimate of the value in India of chemical disinfection as a plague measure, and an estimate which receives no support from the evidence that has been adduced in its favour. Chemical disinfection has never, in itself, proved sufficient to arrest the progress of the disease, for it has failed wherever it has alone been employed, as in Bombay, Parel village, Malabar Hill, Lanauli, Satara, Nasik, Igatpuri, Poona, Ankleshwar, and Jawalapur; whereas the opening up of houses and evacuation, without any disinfection by chemical substances, has in numerous instances proved successful, as in Sukkur, and in many villages in the districts of Dharwar, Surat, Sholapur, and elsewhere. The exclusive application of chemical disinfection is, however, doomed to failure, as it does not provide for the special difficulty, in dealing with plague, caused by the extension of the disease which is effected by rats. At the same time, disinfection by chemical substances is occasionally the only form of disinfection that can be adopted in several houses, but even in these instances it cannot alone be trusted to, and should be combined with prolonged evacuation. It is probably useful as an auxiliary to disinfection of houses by other agencies, and especially by sunlight and air, for it is not unreasonable to suppose that a solution of an efficient disinfectant would prove more serviceable than water alone in reducing the dangers that are incurred during the opening up of houses; and there is sufficient evidence to show that disinfection by chemical substances is the only convenient method of freeing from plague-infection many of the personal effects of patients and other articles in infected houses.

Chemical disinfection, though occasionally useful as an auxiliary measure, has never by itself proved sufficient to arrest plague.

20,439. Gatacre's Report, p. 190.
18,189-99.
20,158; 20,184-190; 20,197-202.
22,062; 22,137.
16,887-891.
18,427; 19,455-64.
21,614.
14,412.
9175.
9; 2145-6.
23,163-8.
23,187-8.
19,953-6.
24,036-40.
8.

B.—The opening up of houses inadequately provided with means for ventilation is a valuable plague measure.

8. The President considers that the fact that openings in the roof were purposely made so as freely to admit sunlight into rooms has not adequately been recognised in paragraph 672 of the Report, and especially in the sentence, "Thus the question of the utility of knocking holes in the roofs and walls resolves itself into a question as to the utility of these openings for bringing the agency of desiccation effectually into operation." It appears to be assumed in the argument against the making of openings in the roof, by untiling or by other means, that the openings were in most cases insufficient for the purpose of admitting sunlight, whereas the contrary is stated in many of the descriptions of the manner in which the openings were made. In confirmation of this statement it is necessary to refer only to the following. Capt. James, I.M.S., describes the holes made in the roofs as being "large enough to admit plenty of sunlight and air into the room below." "An opening not less than 6 feet by 4 was not allowed, and often much larger ones were made in every house in the village." They were so made as to "allow the direct rays to act on the largest portion of the room." Further, referring to houses which were not entirely unroofed, he states that, "owing to the great variation in size of the rooms it is impossible to give any definite dimensions applicable to all cases, but the strip should certainly never be less than 4 feet wide, and in large rooms it may be necessary to remove two or more strips. The only way of seeing whether enough of the roof has been removed is to visit the house at different times of the day, and to notice whether, at one time or another, the sunlight reaches every part of the room." It was the practice in the Mysore State to make such openings in the roof, supplemented generally by openings in the walls, as would ensure the access of direct sunlight to all parts of the floor and to a large part of the interior walls. At Ahmednagar "openings were made so that the rays of the sun could penetrate into the rooms"; at Satara a portion of the roof, about 3 feet broad, was taken off; in the towns and villages in the Cutch State, the tiles were removed about a yard in width, sometimes in two parts of the roof, "and a strong light let into the rooms"; in the villages of the Dharwar district the roofs were "opened by removing the earth and lifting up the bamboos, the whole length of each room for a width of 2 feet;" and in the Sirohi State pretty nearly the whole roof was untiled. Further, the intensity of the sunlight in India and the large daily amount of it during the greater part of the year must be taken into account.

The opening up of houses often done efficiently, so as thoroughly to bring the agencies of sunlight and air into effect.

Capt. James' Report, p. 112, Major Inglis' Report, pp. 33, 155, 162, 171.

Capt. James' Report, p. 169.

24,274.
22,157.
13,474.
23,163.
9,911.

The opening up of houses not an unnecessary measure.

9. It is also stated in paragraph 672 of the Report that the openings made in the houses were unnecessary for bringing the agency of desiccation effectually into operation. While it is undoubtedly the case that openings in the roofs and walls have been so made as to allow of the disinfecting agency of sunlight to come into operation, it does not appear justifiable to assume that they were not also of great value in furthering desiccation. In the great majority of the houses in which plague has occurred, windows were practically absent, and, where present, they were usually represented by small openings, sometimes described in the evidence as mere "slits" in the outside walls. Many of the houses were one-roomed, and could be ventilated only by admitting air through the open doorway. Others contained three rooms, one of which usually depended for its air supply upon the doorway opening into it from a dark and practically unventilated chamber. The floors of the rooms most frequently consist of earth and cowdung placed directly upon the soil, and therefore of materials retentive of moisture, which is supplied to them not only by the water placed on the surface during, for instance, the customary weekly or bi-weekly application of cowdung and water, but also continuously by imbibition from the underlying ground, which in many parts of India, owing to the natural condition of the soil and also to the absence of drainage, contains a large quantity of water. Further, plague bacilli, in the conditions in which they would naturally occur outside of the body, are not easily dried so completely as to be devitalised.

Appendix III., sections I, II, and III, *ante*.

Evidence, II., pp. 8, 9, and 13. 8552; 18,886; 26,344–5.

It is therefore extremely unlikely that, unless the roofs, and often also the walls, were opened up in native houses, unprovided with outside openings sufficiently large to allow of a free circulation of air in the rooms, dryness of even the upper surface of the floors could be produced otherwise than so slowly as to render highly inconvenient and dangerous, if not impracticable as a plague measure, a process of disinfection which partly depends for its success upon the desiccation of the floors.

Evidence, II., pp. 13, 8–10, 8552. Annales de L'Institut Pasteur, 1887. Proceedings of the Royal Society, LVI., 1894, p. 318.

At the same time, it is not to be overlooked that the disinfection, which is so undoubtedly effected by the opening up of houses, is most probably caused not only by desiccation, but also by oxidation, which depends for its accomplishment upon free access of air as well as of light. In connection with this, it may be pointed out that Professors Percy Frankland and Marshall Ward, confirming the previous observations of Roux, have demonstrated that microbes exposed to sunlight are destroyed more quickly when the access of air to them is free than when it is obstructed, and that the exposure of the spores of *Bacillus anthracis* to sunlight *in vacuo*, and therefore without air, "results in no perceptible retardation or destruction of the bacillus, whereas if exposed in contact with air nearly all the spores are killed in the time given."

C.—Results of opening up of houses of greater efficacy than their disinfection by chemical substances.

The opening up of houses recommended as a plague measure. 7855–6; 15,179–81; 20,161; 20,164; 21,153; 21,156; 24,316; 24,342.

1680; 7862; 11,273; 21,097; 23,187–9; 24,418–50. Our Report, para. 650.

10. The President is unable to agree with the opinion implied in section (II.) of paragraph 680 of the Report, that the opening up of houses is not necessary as a measure of disinfection—an opinion which is repeated in section (VI.) of the paragraph. It was frequently stated in evidence that the construction of a large proportion of the native houses was such as to render effective disinfection by chemical substances an operation of so great difficulty as to be practically impossible, and that the providing of sufficiently skilled and constant supervision was unattainable. It is not to be overlooked, also, that the probabilities of success by the use of solutions of even the most powerful disinfectants are dependent upon the supposition that the large majority of the plague bacilli are found only upon the surface of the floor, whereas the relatively porous nature of the materials of earth and cowdung floors, and the conditions to which their surfaces are subjected, are against the supposition. Further, the chemical composition of these, and likewise of concrete floors, is such that the effective ingredients in even strong and acidified solutions of perchloride of mercury would nearly instantaneously be neutralised by contact with them. The assumption that plague bacilli are almost only upon the surface of floors does not, however, greatly strengthen the probabilities of their being devitalised by disinfecting solutions, for it is not the case that the bacilli are generally free or naked, but rather, for the most part, incorporated with sputum and excreta, the constituents of which would protect them from contact with the disinfectant, whose action upon these constituents would, indeed, result in the formation of a surrounding covering, nearly impermeable by the disinfectant.

18,862.

Further, if any bacilli were below the immediate surface or were actually upon the surface but covered "by leaves, bits of rags, &c." they "could hardly be hurt at all," by eight gallons, applied to a 10 by 10 feet surface, of even so strong a disinfectant as an acidified solution of 1 in 725 of perchloride of mercury. Even supposing that these serious difficulties could be overcome, there remains the important fact, introducing an exceptional complication in disinfection for plague, that the room or house is liable to, and very frequently does, contain infected rats, which burrow in the walls and roofs and obviously are not affected by chemical disinfection. However effectually, therefore, the process of chemical disinfection may have been carried out, the house remains as dangerous for occupation after the process as it was before it, for the infected rats would enter the rooms and re-infect them on the first opportunity. It is probably because of this that chemical disinfection alone has so generally failed, while the providing of openings sufficiently large to admit air and light into each room, conjoined with the removal of the inmates from the houses for a period of several weeks, has proved so successful. In so far as adequate unroofing, whether complete or partial, of a house unprovided with a sufficiency of outside openings is a necessary part of the process of disinfection by the agencies of light and air, it does not appear to be in accordance with the evidence to characterise it as "a needlessly drastic measure." The difficulties connected with the efficient application of chemical disinfectants, and the uncertainties regarding the strength of the solution or mixture of any of them required to insure the death of plague bacilli in earth and cow-dung floors, give further support to the value and importance of utilising the disinfecting actions of sunlight and free access of air, which experience has amply shown to be effective for the purpose.

11,460-2; 22,125; Capt. James' Report, pp. 95-100.

11,202-5; 22,693; 22,716; 22,864; 25,794.

1220; 18,189-90; 22,893-7; Campbell's Report, p. 206; General Burnett's Poona Report, p. 2; James' Report, p. 162.

8558-8563; 8578; 18,838-42; 18,862; 26,350-2, 26,369

Our Report Chapter VI., para. 680 (iv.).

D.—*Statement of the measures recommended by the President for adoption in towns and villages.*

Summary of plague measures.

11. In connexion with the above expression of his opinion, and with reference to the policy which has been recommended in paragraphs 726, 727 and 728 of the Report, the President considers that a brief and definite statement of the measures applicable at the beginning and at a later stage of an outbreak of plague, in places of large and small size, respectively, would with advantage be added to the above. In his opinion, the measures may thus be stated:—

A.—In Large Towns, including Cities and Towns of more than 10,000 Inhabitants.

(a.) *At the beginning of the outbreak.*

1. Removal of all plague patients to hospital, except in the very rare cases in which a patient with one or two attendants can be effectively isolated in a sufficiently capacious and well ventilated and lighted room;
2. Isolation of contacts;
3. Evacuation, for at least one month, of a considerable area in proximity to or surrounding the house or houses in which the first cases had occurred;
4. Disinfection by chemical substances of the houses and effects of patients;
5. Disinfection by exposure to sunlight and air of the interior of infected and evacuated houses, wherever required and practicable, and of such articles as cannot without injury be subjected to disinfection by chemical substances;
6. Wholesale destruction of the rats in the city or town, and if mice are numerous, of them also;
7. Inoculation with prophylactic fluid of as large a number of the unaffected as possible, with the inducement of shorter residence in the evacuation camps of those who become inoculated.

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Provided that the first cases are discovered soon after their occurrence, it is highly probable that the outbreak would be suppressed by these measures.

(b.) *At a later stage of the outbreak.*

If, unfortunately, the discovery of the first few cases has not been effected, and the failure of the first five of the above measures would itself suggest this, it may be anticipated that the disease has extended by human communication, and, even more disastrously, because less under control, by communication through infected rats. The prospect of suppressing the outbreak must then be regarded as doubtful, unless the resources at the disposal of the Government and the co-operation of the people render it possible to evacuate the whole city or town. As, however, this is improbable in places which contain considerably more than 10,000 inhabitants, efforts should be made to limit the extension of the disease in the city or town by all or as many as possible of the measures stated under 1, 2, 3, 4, 5, 6, and 7 above, and to limit or prevent the extension into other places by every practicable means. Although the extent of the outbreak may thus be restricted, its extinction cannot confidently be anticipated, and, therefore, it is of supreme importance that the measures recommended for the earliest cases should be strictly and completely carried out at the commencement of the outbreak, while there is yet a reasonable prospect of complete success.

B.—In small Towns and in Villages.

The suppression of an outbreak of plague in a small town or a village is not attended with the great difficulties which are encountered in cities and large towns, nor, in so far as the mere suppression of the disease is concerned, is it necessary to draw a broad distinction between the earlier and the later stages of the outbreak. While, for obvious reasons, it is desirable that early information of the first case or cases should be obtained, so that the measures may be applied as soon as possible, these measures in all stages of the outbreak should be as follows:—

1. Isolation of the patients and of the contacts;
2. Complete evacuation of the town or village for at least one month;
3. Disinfection by opening up to the influence of sunlight and air of all the evacuated houses;
4. Disinfection by chemical substances of the personal effects of the inhabitants before their removal to the evacuation camp;
5. Inoculation of as many of the inhabitants as possible;
6. Destruction of rats, and if mice are numerous, of them also.

If the first four of the above measures are efficiently carried out, it may confidently be anticipated that the outbreak will be suppressed. At the same time, all measures that can be applied for preventing the extension of the disease into other places should also be adopted, and the President thinks that experience has shown that the most effective of them are the regulated supervision of the evacuated and the securing for them of properly constructed huts in a well arranged and situated camp.

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SUMMARY

OF THE

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